



COLONY AND PROTECTORATE OF KENYA

DEPARTMENT OF AGRICULTURE
ANNUAL REPORT
1956

Volume II—Record of Investigations

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DEPARTMENT OF AGRICULTURE
ANNUAL REPORT
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ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST, 1956

The organization of the Entomological Section during the year consisted of headquarters at the Scott Agricultural Laboratories with outstations in the Rift Valley, Nyanza and Coast Provinces, at Nakuru, Kibos and Matuga. Headquarters deal with administration, general investigations, general advisory work, insect identification and plant protection services. Nakuru with cereal and wattle pests, Kibos with cotton and sorghum pests, Matuga with coco-nut and citrus pests and all these stations with other general investigations and advisory work.

Plant Protection

Mr. E. S. Duncan, Plant Inspector, reports as follows:—

“NEW LEGISLATION

A meeting was held at Muguga on 31st May, 1956, co-ordinating the policy in the control of plant imports and exports for the East African territories.

IMPORTATION OF PLANTS

During the year a total of 1,831 plant importation permits were issued, showing an increase of 34 over the previous year's figure. Many more permits would have been issued for produce such as onions, garlic, etc., coming from Egypt, had it not been for the Suez Canal dispute. Parcels imported through the Post Office and inspected at the Scott Laboratories numbered 2,754, showing an increase of 46 over last year's figure. Many more consignments arrived by air compared with the previous year's figure: in particular importations of fresh fruit from South Africa. Revenue collected from fines, Sh. 496.

EXPORT OF PLANTS

The number of export certificates issued continued to rise steadily. This year's figure was 574; many of the plants were fumigated with HCN gas.

FUMIGATIONS

Fumigation was carried out with HCN gas on cut flowers imported into Kenya and also on some material exported. Methyl bromide was used on stored products and ethylene dibromide on mangoes from India.

INSECTS INTERCEPTED

Among the insects intercepted the following identified species are mentioned:—

Argyroplote leucotreta (false codling moth), South Africa, peaches (fruit), *Ephestia cautella*, South Africa, peaches (fruit), *Coccidae*, *Parlatoria proteus* Israel, oranges (fruit). *Tortricidae*, *Pseudogalleria peltastica* Meyr. South Africa, peaches. *Trypetidae*, *Dacus cucurbitae* Coq. India, pomegranate.”

Stored Products

The Pest Infestation of Stored Products Committee held two meetings during 1956.

Following reports of an outbreak of *Trogoderma* in Zanzibar Mr. S. Kockum went there to investigate the position in view of the danger of this serious pest spreading to the mainland. The presence of this pest in Rhodesia and Nyasaland has now been confirmed. Increased inspection at the coast of imported goods from Zanzibar and the strengthening of the legislation were steps taken to prevent the spread of this pest to Kenya.

During the year experiments were continued on insecticidal treatments for grain in bags. A new crib experiment was set up by the end of January which was still continuing at the end of the year. A large stack experiment was started intended to give information on the effect of insecticidal dust treatments used on the outside of bags to prevent reinfestation of fumigated grain. Railway trucks have been treated with various insecticides with resins but these experiments have not yet been carried to a definite conclusion. A plywood silo was received from England and erected at the laboratory grounds for experimental purposes and a first experiment carried out. Apparatus and equipment for a study of methyl bromide gas distribution in large stacks were received at the end of the year. Outbreaks of *Ephestia* in the Maize Control stores were experienced during the year and fog-spraying machines tried out. Pyrethrum piperonyl butoxide in oil was used with encouraging results with a battery of small Microsol machines.

A survey of native storage methods among the Meru and Tharaka tribes was carried out.

Much of the experimental work will be concluded and written up at the beginning of the coming year. An article "The Khapra Beetle" was published in *The Kenya Farmer* and *K.I.O. Fortnightly*. Several advisory articles were published in the *K.I.O. Fortnightly*.

Insecticide Investigations

Mr. J. F. Graham, Entomologist, Scott Agricultural Laboratories, reports as follows:—

"PINEAPPLE MEALYBUG (*Dysmicoccus brevipes*)

Work started by Mr. Bullock was continued.

Spraying of Diazinon or malathion almost eliminated mealybugs from the leaves of infested pineapples but reinfestation from the roots occurred later. Dipping planting material in insecticide for five minutes gave good results with Diazinon or malathion at 0.1 per cent. Both insecticides reduce the initial mealybug population, and while 100 per cent kill cannot be claimed under field conditions such dipping is recommended where methyl bromide fumigation is impracticable.

RED SCALE (*Aonidiella aurantii*)

Good control was achieved by Diazinon at 0.075 per cent.

FALSE CODLING MOTH (*Argyroplote leucoireta*)

Some reduction in infestation was achieved in a block of 25 orange trees at Machakos after four sprayings of endrin 0.03 per cent at fortnightly intervals but reinfestation from surrounding trees occurred. In another trial carried out near Thika spraying with Diazinon gave no reduction.

CITRUS BUD MITE (*Aceria sheldoni*)

Two sprayings of chlorobenzilate at 0.03 per cent separated by an interval of 14 days reduced infestation to low proportions.

THRIPS IN BANANAS (*Hercinothrips bicinctus*)

Severe damage to bananas, causing them to be unfit for food, was caused by the above species recorded in Kenya for the first time. Good control was given by a 0.036 per cent B.H.C. spray but a dieldrin/coumarone resin spray (approximately 0.03 per cent dieldrin plus 0.003 per cent coumarone resin C.469) was outstandingly good and gave complete control.

ARMYWORM (*Laphygma exempta*)

This pest occurred at the beginning and the end of the year. A good kill was achieved by spraying with endrin 0.024 per cent but this is unsuitable for food crops required for immediate consumption because of toxic residues. Baits of B.H.C. or aldrin in bran had only limited success but might be satisfactory on bare ground. D.D.T. remains the standard treatment.

TERMITE NESTS

Termite nests of mound-dwelling species were controlled by pouring aldrin or dieldrin in water down the ventilation shafts. Some nests needed a second treatment. Two gallons of 0.075 per cent aldrin or 0.06 per cent dieldrin were used per nest.

RICE PESTS

Investigations at Mwea/Tebere irrigation scheme showed that rice was attacked by the leaf-mining Hispid, *Trichispa sericea*, by a shoot fly, *Notiphila setigera* and two stem borers *Rhinaphe vectiferella* and *Sesamia calamistis*. The stem borers are particularly serious pests in that they appear to cause empty heads resulting in a poor yield.

MILKY DISEASE

First attempts to establish milky disease types A and B of Japanese beetle in chafer grubs of the genus *Schizonycha* from Kitale by inoculation were not successful. These will be continued.

HARVESTER ANTS

A survey was carried out in the Samburu District on the incidence of harvester ants and a report issued giving control recommendations and suggesting large-scale trials."

Entomological Investigations—Coast Province

Mr. P. E. Wheatley, Entomologist, Coast Province, reports as follows:—

"RHINOCEROS BEETLE (*Oryctes monoceros*)

There would appear to be some improvement in the position in Kwale District, although serious damage continues in Kilifi District. It is intended to make a full analysis of the effectiveness of the Coconut Improvement Scheme in controlling this pest by destruction of breeding places.

FALSE CODLING MOTH (*Argyroplote leucotreta*)

This insect caused serious damage to oranges from the Kaloleni area. The destruction of infested oranges is made difficult by the firm belief of the growers that premature colouring and ripening is due solely to the heat of the sun.

CITRUS SCALES AND MITES

These pests continue to do serious damage to nearly all citrus trees. The introduction of the new insecticide Diazinon and the miticide chlorobenzilate now ensure a good control of the main citrus pests without the use of highly toxic substances such as the more lethal organo-phosphorus insecticides. However, local growers are loath to incur the expenditure involved in applying insecticides.

ARMYWORM

An outbreak in the "low hills" area of the Voi District at the beginning of December lasted three weeks, and late sown maize and sorghum suffered considerably. Armyworm was also present in relatively small numbers over the whole province following the short rains.

Teleonemia scrupulosa

Introduced to Kenya from Hawaii to control the weed *Lantana*, this Tingid has continued to spread slowly from the original liberation site. Two further liberations were made during the year at Gazi and Likoni. Evidence so far suggests that this insect does considerable damage to the weed when populations are high, but is unlikely to effect appreciable control.

THE COREID BUG OF COCO-NUTS

Experiments aimed at increasing populations of the predaceous *Oecophylla* ant were laid down in September and October, and will continue for a minimum period of one year. These involve insecticidal treatments designed to combat the natural enemies of *Oecophylla*. An experiment consisting of bridging palm bases with palm fronds in an endeavour to encourage *Oecophylla* was discontinued in September after it had run one complete year; there had been a general reduction of *Oecophylla* on both experimental and control plots. Hand-spraying experiments are planned against this bug. Cashew nut has been shown to be an alternative host during the fruiting season, and nymphs and adults have been found feeding on mango fruits. Females feeding on mango, however, have not yet been shown to be fertile. No accurate assessment of the damage to these crops by *Pseudotheraptus wayi* has yet been made."

Entomological Investigations—Nyanza Province

Mr. T. J. Crowe, Entomologist, Nyanza reports as follows:—

"Results of 1955-6 work on cotton pests are fully reported in the Empire Cotton Growing Corporation Progress Report (Kenya). Results of current work are not yet available; the conclusions given below are only provisional.

SURVEY

Routine counts of pests on African-grown cotton continued. In the area fringing Lake Victoria numbers of cotton stainer (*Dysdercus* spp.) were greater than in the two previous seasons. As the peak of population was later in the year an increase in stained cotton is not expected. Much shedding of bolls early in the season was due to American Bollworm (*Heliothis armigera*) but some Spiny Bollworm (*Earias* spp.) was present. *Lygus* attack was lighter than average. 'Physiological shedding' of bolls undamaged by insects was almost certainly due to mid-season drought (63.1 per cent compared with 45.4 per cent for last year). A brief Red Spider Mite attack on the Kano plains is unlikely to affect yields. Near the Uganda border *Lygus* attack was fairly severe in timely planted cotton. The peasant crop, late planted due to poor June/July rains, escaped damage to some extent but will yield poorly due to untimely planting. *Heliothis* was locally severe but bollworms caused little damage. Aphids (*Aphis gossypii*) Jassids (*Empoasca* spp.) and Pink Bollworms (*Platyedra gossypiella*) caused only slight damage this season.

EXPERIMENTAL

A pest assessment trial at Kibos gave low yields due to unsatisfactory rains. Yields of seed cotton were 581 lb./acre for controls, 762 lb./acre where *Lygus* and *Heliothis* were controlled and 1,038 lb./acre where optimum control of all pests was obtained. Stainers caused greatest cash loss by reducing both yield and quality.

A single replicate of a dusting trial was planted in the first week of April on 18 sites in the lakeshore area. Treatments were 80 lb. of cotton dust per acre (3 per cent gamma B.H.C./10 per cent D.D.T.).

- (a) Eight applications of 10 lb./acre at 6-day intervals.
- (b) Five applications of 16 lb./acre at 10-day intervals.
- (c) Untreated.

Dusting began in the first week of August. Provisional results show that everywhere yield increases have, at least, covered the cost of treatment while on several sites treatments (a) and (b) have yielded twice as much as (c). In a Kibos trial the above were also compared with 60 lb. of cotton dust applied under similar regimes. All treatments outyielded the controls but did not differ significantly among themselves.

SUGAR CANE

Dipping the setts in 0.1 per cent dieldrin for 10 minutes before planting was better than B.H.C. dust treatments against termites, and doubled the yield. Untreated setts can be almost completely devoured whereas dieldrin-treated setts produce a good stand.

SORGHUM

Infestation by *Busseola fusca* in a trial at Kibos gave only 7.0 per cent infested nodes compared with 23.8 per cent in 1955. Two run-off sprays of 0.075 per cent endrin reduced the infestation to 3.2 per cent and a single late spraying reduced it to 5.6 per cent. Yield increases were not significant when compared with controls. Yield increases were associated with increased numbers of tillers, possibly due to control of Sorghum Shoot Fly, *Atherigona indica*.

SWEET POTATOES

An infestation of the Spiny Caterpillar, *Achraea acerata*, was controlled by sprays of endrin and chlordion. A marked increase in yield is anticipated.

BANANA WEEVIL

A trial to test cultural and chemical control was laid down at Busia."

Entomological Investigations—Rift Valley Province

Mr. J. Bullock, Entomologist, Rift Valley Province, reports as follows:—

"The main work of the year was on Barley Fly (*Hylemyia arambourgi*), Maize Stalk borer (*Busseola fusca*), Ol Kalou Beetle (*Heteronychus* spp.) and *Argyrotagme niobe* Weym.

BARLEY FLY (*Hylemyia arambourgi*)

Substantial loss of crops was not experienced this year, probably due to farmers using recommended control methods. In the few cases of loss that were reported, it was found that the seed had not been dressed, or had been dressed either inadequately, or with an unsuitable insecticide. A small-plot experiment was performed at Njoro using eight insecticidal treatments. The results, based on the percentage of attacked tillers, show that either aldrin 40 per cent wettable powder applied at 12 oz. per 100 lb. of seed, or dieldrin 50 per cent wettable powder at 10 oz. per 100 lb. of seed will give adequate control. A "sticker", methyl cellulose, was applied to the seed as a slurry, but did not enhance the control. The use of endrin, dieldrin and aldrin emulsions also gave good results, but are not recommended because of the inconvenience of mixing. Some young barley, which was being badly attacked, was saved by a spray of endrin 19.5 per cent emulsion.

The search for alternate hosts has been continued and dipterous stem-borers have been found in maize, *Eleusine* spp., *Digitaria* sp., *Setaria* sp., *Brachiaria* sp., and *Chloris gayana* (Rhodes grass). A number of specimens of a dipterous larva with characters identical with those of *H. arambourgi* were found on *C. gayana*. Observations at Ol Joro Orok indicated that the barley varieties Abed Kenia and Herta are somewhat more susceptible than Carlsberg and No. 5. The known range over which the fly can cause damage now includes Ol Joro Orok and Nanyuki-Naro Moru-Timau.

MAIZE STALK BORER (*Busseola fusca*)

The main attack was late this year; heavy infestations did not occur on experimental plots until late June when the majority of early planted maize was too far advanced for satisfactory treatment, or trials. An aerial spraying experiment, using D.D.T. 25 per cent, endrin 19.5 per cent and malathion 50 per cent emulsions, was started on land at Rongai on April 20th. At this date, 4.3 per cent of the hills were infested, and this figure had only increased by 0.2 per cent two weeks later. Counts of larvae found within the funnels of infested maize indicate that both malathion and endrin had reduced the numbers present by about 60 per cent, but significant differences were not found between the yields of control and treated plots. A hand-dressing trial, using endrin, malathion, B.H.C. and D.D.T. emulsions and D.D.T. dust indicated that endrin and D.D.T. (dust and emulsion) give better control than either malathion or B.H.C. A further hand-dressing trial was performed at Kitale, under the supervision of the Agricultural Officer (Experiments) comparing D.D.T. 25 per cent emulsion at two strengths with D.D.T. dust. No significant differences were found between the treatments.

Maize planted at six weekly intervals at Njoro showed the build-up of a population of *B. fusca*. Maize planted in the third week of April suffered only light attack, that at the end of May showed a 60 per cent attack and that later about a 95 per cent attack. A further illustration of the danger of out-of-season planting was found in late October. Maize which had been planted in August and was standing about a metre high showed 100 per cent attack, and an average infestation per plant of 19 larvae and pupae, involving all stages of larva from first instars onwards. The larger plants showed an average of over 30 larvae per plant.

Lepidopterous larvae, in all cases probably *B. fusca*, have been recorded on wheat, barley, *Eleusine jaegeri*, *Sorghum vulgare* and *S. verticilliflorum*, *Setaria sphacelata* and *Phalaris canariensis*.

OL KALOU BEETLE (*Heteronychus* spp.)

An experiment to compare the efficacy of three seed dressings against *Heteronychus* spp. was laid down at Ol Joro Orok under the supervision of the Agricultural Officer (Experiments) Ol Joro Orok. The results show aldrin and B.H.C. to be equally effective, whilst a proprietary brand of dieldrin 20 per cent (used at the recommended rate), although giving some measure of protection, was less effective than either of the others.

WATTLE HAIRY CATERPILLAR (*Argyrostagme niobe*)

(Lep.-Lymantriidae), although known in Kenya for many years, has not previously been recorded as a pest. In January, 1956, it was reported to have defoliated 300 acres of wattle (*Acacia mollissima*) in the Turbo area of the Uasin Gishu. In June, the attack had spread to cover, 5,000 acres, but by September the larvae were dying out rapidly, due to the presence of a polyhedral wilt disease. Investigations of the pest have been made throughout the year in co-operation with research officers of the Plateau Wattle Company. They have, in the main, examined the possibilities of insecticidal control. A full study of the life history has been made, together with a study of parasites and predators.

ARMYWORM (*Laphygma exempta*)

Three heavy outbreaks of this pest occurred during the period March to May. The attacks involved the Trans Nzoia and Uasin Gishu, that part of Nakuru District bordering the Kamasia Reserve and the Reserve itself, and the Uaso Nyiro area of Nanyuki. A later report confirms its presence in the Samburu District, at about the same time. The attacks were countered by the use of

D.D.T. 25 per cent emulsion, applied either from the air, or by tractor-drawn sprayers. This was effective on crop land; but on grazing, and especially at Nanyuki, the area involved was too great for any control measures to be practicable. A further slight outbreak occurred on wheat in the Solai area in late June. This was promptly tackled by the farmers and no damage occurred. An Ichneumonoid larval parasite, and a Tachinid pupal parasite were found in large numbers in larvae collected for breeding.

CUTWORM

Suitable cutworm attacks for experiments to be carried out did not occur. One serious attack in Nakuru District on dressed maize was controlled by replanting at a depth of 2 in. and using an aldrin seed dressing, which was applied to dampened grain. The attacked maize had had an aldrin seed dressing but had been planted about 4 in. deep and at this depth it appears the dressing is not effective against this insect.

PERKERRA IRRIGATION SCHEME

Several visits were made to the Scheme during the year and the following pests noted: *Heliothis armigera* on tomatoes; *Dacus* sp. on Cucurbits; *Dysdercus cardinalis*, *Oxycarenus hyalinipennis* and *Coryzus rubricosus* on Hibiscus; termites on maize, tomatoes and groundnuts; mealybug on sugar cane; and brown scale on citrus.

APHIDS

Two small outbreaks of aphid on wheat occurred in the Trans Nzoia. The second was controlled by aerial spraying with malathion 50 per cent.

HARVESTER ANTS (*Messor* sp.)

Attacks by this insect have been controlled either by a bait of aldrin 40 per cent in maize meal in ratios or 1:32 or by use of a solution of 1 per cent dieldrin. A visit to the Samburu District was made in October, with Mr. J. F. Graham, to ascertain the prospects of controlling the ant and increasing the pasturing potential."

Systematic Study of Coccidae

Mr. G. De Lotto, Entomologist (Taxonomy) Scott Agricultural Laboratories, continued his work on the taxonomy of the Coccidae. The detailed study of the mealybugs of Africa south of the Sahara being carried out in collaboration with Dr. Williams of the Commonwealth Institute of Entomology was continued.

Mr. G. De Lotto reports as follows:—

"The first paper of the series dealing with the redescription and revision of the Ethiopian mealybugs (*Pseudococcidae*) has been finished and sent to the Press. It included the species originally described by H. C. James from East Africa. During the year a critical review of some genera of Coccids which include species of economic importance was begun and two papers dealing mostly with local species of *Saissetia* have already been completed. A study on species of the genus *Coccus* is still under way and will be ready in a short time. Preliminary investigations are being carried out on the symbiotic flora of some important species of Coccids in view of its possible application as a reliable method for the identification of species structurally very closely allied."

Publications

G. De Lotto—

"New Diaspidini (Homoptera: Coccoidea: Diaspididae) from Kenya." *Proc. R. ent. Soc. Lond.*, (B) 25 (1956), pp. 17-24.

"The Identity of some East African Species of Saissetia (Homoptera: Coccidae)." *Bull. ent. Res.*, 46 (1956), pp. 239-249.

"A new Ceroplastodes (Homoptera Coccoidae) from Kenya." *Jl. ent. Soc. Southern Afr.*, 19 (2) (1956).

S. Kockum—

"The Khapra Beetle." *K.I.O. Fortnightly*, 16th October, 1956.

"Maize Storage on Farms." *K.I.O. Fortnightly*, 16th October, 1956.

"Maize Storage on Farms." *K.I.O. Fortnightly*, 2nd November, 1956.

"The Control of Stored Products Insects." *K.I.O. Fortnightly*, 2nd November, 1956.

J. F. Graham—

"Destruction of Harvester Ants." *K.I.O. Fortnightly*, 1st January, 1956.

"Barley Fly and its Control." *Kenya Weekly News*, 30th March, 1956.

"Black Wheat Beetle." *Kenya Weekly News*, 6th April, 1956.

Advisory Leaflets

Advisory leaflets were produced on the following subjects, copies of these are available on application:—

Bean Fly (*Melanagromyza phaseoli* Coq.).

Armyworm (*Laphygma exempta* Walk).

Black Wheat Beetle (*Heteronychus consimilis* Klb. and other species of genus).

Banana Weevil (*Cosmopolites sordidus* Germ).

Cotton Stainer (*Dysdercus* spp.).

Maize Stalk Borer (*Busseola fusca* Full).

Acknowledgments

The essential help of the Commonwealth Institute of Entomology with special reference to the identification of insects is once again acknowledged with pleasure.

R. LE PELLEY,
Senior Entomologist.

ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST, 1956

An increasing part of the work of the section has been devoted to activities not directly concerned with plant pathology. This development has precluded any extensive research work. As forecast in the previous report much of the work entailed is in the nature of a public service rather than an investigation of *ad hoc* problems. Nevertheless, the inquiries received present a number of minor research problems in identification of the cause of the disease and of the pathogen concerned. The legume inoculant service has been expanded to meet the demands of the Pasture Research Team and the requirements of the adjacent territories. It now occupies the major proportion of the time of the Plant Pathologist and a scientific assistant. A further expansion of the work on potatoes is now in operation to include the production of high quality seed of recently introduced and standard commercial varieties as well as the blight resistant hybrids. Pending the appointment of an officer specifically for this purpose the work is being undertaken by the Plant Pathological Section. An added and entirely unforeseen commitment was the requirement to undertake once more, after a lapse of four years, the whole of the work on Stem Rust of wheat which was transferred back from the Plant Breeding Station, Njoro, where it had been under the direction of the Senior Plant Breeder, to the Scott Laboratory. The Seed Testing Laboratory has remained an integral part of the Plant Pathological Section. The launching of the Seeds Ordinance and the drafting of the accompanying Rules has fallen in part to the Senior Plant Pathologist.

During the year 516 specimens of diseased plant material were received at the laboratory. Two hundred and fifteen of these came from members of the public and 301 from departmental officers. Ninety-six visits were made to the laboratory in connexion with this material.

Diseases of African-grown and plantation-grown cash crops included Leaf Spot, *Cercospora personata*, a wilt disease associated with *Macrophomina phaseoli*, and *Rhizoctonia solani* on groundnuts. Chillies, in various localities, were affected by a mosaic disease, a *Fusarium* wilt and the leaf diseases, *Cercospora unamunoi* and *Leveillula taurica*. No instance of *Colletotrichum capsici*, present in the previous year, was recorded. A root and stem rot of cassava at the Coast was associated with a species of *Coprinus*. Die-back of the same host was apparently caused by a *Gloeosporium-Botryodiplodia* combination. Castor oil (*Ricinus*) die-back was associated with *Macrophomina phaseoli* and *Botryodiplodia*. A disease of the inflorescences causing a rot of the unopened buds yielded *Botryosphaeria* sp. Leaf Spots, caused by *Cercospora ricinella* and Rust *Melampsora ricini* were also received. On cotton *Ramularia areola* and the Angular Leaf Spot *Xanthomonas malvacearum* occurred on irrigated plots. Heavy attacks of *Oidium* occurred on green gram (*Phaseolus radiatus*). Pigeon pea (*Cajanus indicus*), at the Coast, was affected by a disorder producing short longitudinal splits of the bark and a form of "stem pitting" producing a die-back followed by a collapse of the plants. The cause, which was not ascertained, is possibly physiological or of virus origin. A study of the abnormality could not be undertaken. Two leaf spots *Cercospora cajani* and *Uromyces dolicholi* were recorded for the first time. A number of specimens of pyrethrum were sent in on which were recorded *Ascochyta* sp. and *Ramularia bellunensis* on buds and flowers and various stages of crown rot and die-back, the two last being induced by heavy Thrips and Root Eelworm attack. A physiological or "False Bud" disease is attributed by the Senior Pyrethrum Officer to a form of clonal or varietal weakness. On flax, one instance only of Pasma Disease, *Sphaerella linorum* was notified. A die-back of mature trees

of cashew nut at the Coast is under investigation. *Armillaria mellea* was the cause of considerable loss of tea bushes in nurseries serving African tea growing in the Mount Kenya district. In the same nurseries a root disease attributed to *Ganoderma* sp. was also present. The effect of this was the destruction of the lateral root system in contrast to that of the pronounced "Collar Crack" effect of *Armillaria mellea*. An unidentified *Phycomycete* was the cause of a stool rot of sugar cane from Nyanza.

Citrus diseases consisted of suspected Psorosis, Concentric Ring Blotch and "Gum Spot" in addition to the usual diseases associated with *Gloeosporium gloeosporioides* and *Botryodiplodia theobromae*. A species of *Geotrichum* was isolated from citrus roots. Powdery Mildew of mango was common and occasionally serious on the inflorescences. *Ovulariopsis papayae*, *Ascochyta caricae* and *Glomerella cingulata* occurred on pawpaw. One instance of Panama disease was observed on bananas for the first time from the Kenya Highlands. Diseases of deciduous fruits included *Rosellinea necatrix*, powdery mildew and die-back of apple and *Septoria rubi* on raspberry. Diseases of grape included Anthraconose and *Elsinoe ampelina*. Crown Gall was sent in on almond.

Seventy-three specimens of diseases of cereals were examined, mostly in connexion with suspected "Take All" and on behalf of the Senior Plant Breeder and departmental officers. The incidence and distribution of these diseases is reported on by the Senior Plant Breeder. On maize *Sclerospora sorghi* and *Physoderma maydis* appeared in the Coast Province but not elsewhere. No severe attack of *Puccinia polysora* was reported and the incidence of *Helminthosporium turcicum* and *Puccinia sorghi* was normal. Reports and specimens were received of a so-called "Blind Cob" disease from the Trans Nzoia which did not appear to be caused by any organism. The so-called Trans Nzoia disease appeared to be more in evidence than last year. Two instances were notified of the Dry Rot, *Diplodia zeae*, and one specimen only of Head Smut, *Sphacelotheca reiliana*. On irrigated rice in the Highlands *Ophiobolus oryzinus* and *Leptosphaeria salvinii* were the cause of Foot Rot. An extensive occurrence of "Straight Heads" in one irrigation scheme was attributed to unfavourable weather at the time of heading out. Diseases of oats and barley are now familiar to agricultural officers; only one specimen of Loose Smut on oats and three of *Puccinia graminis* on barley were sent in.

Diseases of vegetables included *Puccinia asparagi* on asparagus; *Macrophomina phaseoli*, Rust, *Uromyces phaseolorum*, *Colletotrichum lindemuthianum* and Halo Blight on *Phaseolus*; *Xanthomonas campestris*, *Peronospora parasitica* and *Cystopus candidus* on Brassicas; *Septoria apii-graveolentis* and *Bacterium carotovorum* on celery; *Ramularia armoraciae* on horse radish; *Septoria lactucae* and *Bacterium carotovorum* on lettuce; *Ascochyta pisi* and *Erysiphe polygoni* on peas. Carrot and parsnips were severely attacked by the Root Knot Eelworm. On account of the prolonged wet periods at the higher altitudes some loss of potato seed pieces through bacterial rot occurred. It was noted that the white-skinned varieties suffered considerably less than the red skinned. The rot caused by *Pseudomonas solanacearum* was more widespread and severe than in the previous year. *Geotrichum candidum* was isolated from a rot of tubers in the field. Blight, *Phytophthora infestans* was widespread on both potatoes and tomatoes, and caused considerable loss of the latter.

Diseases of ornamentals were on the whole more in evidence than in the previous year. Gladioli were seriously affected by rust, *Uromyces gladioli* and by the "neck-rot" phase of *Botrytis gladiolorum* which last caused considerable loss to producers of cut flowers. Carnations and *Matthiola inflorescences* were affected by a petal disease cause by *Glomerella cingulata* and leaf and stem

diseases of carnation were caused variously by *Uromyces dianthi*, *Septoria dianthi*, *Heterosporium echinulatum* and *Heteropatella valtellsensis*. *Cystopus tragopogonis*, *Ascochyta gerberae* and *Septoria gerberae* were common on Barberton daisy. *Botrytis cinerea* was the cause of a flower rot of pansy, a collapse of *Polyanthus* leaves and a rot of anemone corms and leaves. *Puccinia granularis* caused damage in a number of instances of cultivated *Pelargoniums*. Heavy attacks of mildew, *Leveillula taurica* on *Romneya coulteri* and *Erysiphe polygoni* on *Delphinium* were of common occurrence. *Diplocarpon rosae* and *Sphaerotheca pannosa* were also common on roses in most localities. Specimens of the Root Eelworm were received on *Antirrhinum*, sweet pea and *Anchusa*.

Grass and fodder crop diseases included *Rosellinia necatrix*, *Peronospora trifoliorum* and *Pseudopeziza medicaginis* on lucerne; an unidentified *Stemphylium* leaf spot of Russian comfrey; a "little leaf" disease of clover and a tuber rot of "Topine" caused by *Rhizoctonia solani*. One instance occurred of *Phoma lingam* on kale. Ergot occurred with greater frequency than in the previous year on various grasses particularly on *Panicum maximum*. *Helminthosporium turcicum* and *Puccinia purpurea* were prevalent on *Sorghum* spp. in the Trans Nzoia. An unidentified *Helminthosporium* occurred on *Chloris gayana* and *Helminthosporium cynodontis* on *Cynodon*. *Puccinia graminis* was sent in on cocksfoot, *Dactylis glomerata* and ryegrass *Lolium* sp. Bunt, *Tilletia echinosperma* and *T. ayresii* was particularly severe on *Setaria sphacelata* and *Panicum maximum* respectively. Sunflower, grown as a field crop was attacked by the Root Eelworm.

During the year a few plant disease fungi not previously recorded for Kenya made their appearance. Two diseases of maize, *Physoderma maydis* and *Sclerospora sorghi* occurred in the Coast Province. The latter fungus had previously been recorded on Sorghum only. *Ophiobolus oryzinus* (Arkansas Foot Rot) was determined on rice and is apparently a new record for East Africa. *Ramularia armoraciae* on horse radish does not appear to have been previously recorded from the African Continent. The *Glomerella* disease of the inflorescences of cultivated stocks has not been received before by the Commonwealth Mycological Institute, and that on the flowers of carnation is similarly reported to differ from previous collections of this fungus. Other new records are *Cercospora cajani* and *Uromyces dolicholi* on *Cajanus indicus*; *Geotricum candidum* on potato tubers and *Heteropatella valtellsensis* on carnations. Two diseases, *Diplodia zeae* on maize and *Elsinoe ampelina* on the vine, were recorded for the first time for over 20 years.

The mycological herbarium, which now comprises 147 genera has been further expanded. During the year 105 new collections were added and 35 collections sent to the Commonwealth Mycological Institute for determination and deposit. The following identifications of collections were received:—

Puccinia purpureum on *Sorghum vulgare*; *Glomerella cingulata* on *Matthiola incana*; *Botrytis gladiolorum* on *Gladiolus* sp.; *Fusarium oxysporum* f. *gladioli* on *Gladiolus* sp.; *Macrophomina phaseoli* on *Phaseolus vulgaris*; *Ophiobolus graminis* on *Triticum vulgare*; *Leptosphaeria oryzina* on *Oryza sativa*; *Ophiobolus oryzinus* on *Oryza sativa*; *Leptosphaeria salvinii* on *Oryza sativa*; *Heteropatella valtellsensis* on *Dianthus caryophyllus*; *Myrothecium roriduum* on *Lycopersicum esculentum*; *Physoderma maydis* on *Zea mays*; *Sclerospora sorghi* on *Zea mays*; *Ramularia armoraciae* on *Armoracia rusticana*; *Helminthosporium turcicum* on *Zea mays*; *Helminthosporium turcicum* on *Sorghum sudanense*; *Dendryphium laxum* on *Hordeum vulgare*; *Diplodia zeae* on *Zea mays*; *Aspergillus flavus* on *Coffea arabica*; *Aspergillus ochraceus* on *Coffea arabica*; *Penicillium cyclopium* on *Phaseolus vulgaris*; *Corticium solani* on *Helianthus tuberosus*

x *H. macrophyllus*; *Geotrichum candidum* on *Solanum tuberosum*; *Pullularia pullulans* on painted surfaces; *Curvularia pallens* on painted surfaces; *Helminthosporium* sp. on *Chloris gayana*; *Colletotrichum* sp. on *Dianthus caryophyllus*; *Paecilomyces* sp. on *Zea mays*; *Geotrichum* sp. on *Citrus* sp.; *Dothiorella* sp. on painted surfaces.

In addition three earlier collections of Kenya rusts were identified by Dr. Cummins of Purdue University as follows:—

Uromyces kenyensis on *Chloris myriostachya*; *Phakopsora loudetiae* on *Loudetia kagerensis*; and *Puccinia cissi* on *Cissus* sp., the type collection.

Investigations not directly connected with plant pathology included an examination of painted panels for fungal deterioration for the Public Works Department. The fungi isolated from these surfaces were *Pullularia pullulans*, *Curvularia pallens* and *Dothiorella* sp. Core samples from electric cable posts were examined for fungal decay for the East African Power and Lighting Company, and a number of cases of imported fruit were reported on for loss in transit on behalf of insurance companies.

Wheat Stem Rust

It was found that samples of dried rust of the various physiological forms received from the Plant Breeding Station were no longer viable. It was therefore decided to start the rust work at the Scott Laboratory *ab initio*. Collections of rust from the Senior Plant Breeder have been tested on the differentials with a view to re-establishing the rust collection and verifying the existence of forms of rust now recorded in the Colony. An assistant was trained in the technique early in the year but left after six months which necessitated the training of a further assistant after that period. Owing to the interval between the rust work leaving and returning to the Scott Laboratory the Senior Plant Pathologist was the only one of the staff having the requisite knowledge and experience of the work. Seventeen collections were being grown in culture by the end of the year. By then, however, no very clear picture of the forms involved had emerged but the rusts are being maintained pending further clarification. It seems, however, that none of the forms prior to No. 12 are now of any importance and there is evidence of a new form No. 17 having made its appearance. The position has not yet recovered sufficiently for testing of the Plant Breeder's hybrids to be undertaken. Some trouble encountered for the first time, was caused by invasion of the uredo pustules by *Darluca filum*.

Seed-testing Laboratory

The number of seed samples received for testing was approximately the same as in the previous year, being 1,560 as against 1,593 in 1955. The samples consisted of cereals 947, 300 more than 1955, grasses 260, vegetables 179, legumes 99, flower seeds 14 and miscellaneous seeds 61.

The series of experiments on the maturation of barley as shown by germination on sterilized sand versus unsterilized soil was continued throughout the year. The varieties used were Prior, Research, Kenia, Carlsberg, Proctor, No. 5 and Heimdal. Of these, Research reached maturity first and Prior considerably later. The remainder reached maturity at about the same time. In this experiment none of them did better in sand. Tests were carried out on seed of cocksfoot and *Setaria* for the Grassland Research Station; on barley and oats for the Plant Breeding Station and on stored cotton from the Coast Province. Tests were also done on samples for the annual maize competition and on exhibits for competition at the Royal Show. Further tests were done on vegetable, herb and fodder seed received by an importer from overseas. It was found that, on arrival,

the germination was considerably lower than that claimed by the exporting firm. Germination was, however, found to have reached approximately the pre-export value after storage for two months. The low figure obtained after arrival, however, caused some consternation to the exporting firm who asked for samples of the bulk to be flown back to them immediately on arrival in Kenya. These samples were also found to give a lower figure than the original pre-export samples. The seeds tested were fodder beet, sage, spinach and *Capsicum*. Later, further samples of various vegetable seeds packed in special containers were tested. In most cases germination was found to be little lower than that given by the exporters, the difference being from 4 per cent to 10 per cent lower. Exceptions were leek and fennel, being 60 per cent and 40 per cent lower respectively.

Samples of barley were received from Ruanda Urundi with a request from the Belgian Consul at Kampala that the seed-testing laboratory should assist them with germination and purity tests. The usual half-yearly check tests of stock were carried out for a seed firm in Nairobi.

There has been an increase in the number of samples of Nandi *Setaria* sent in during the year. Both this grass and *Panicum maximum* showed an improvement over the previous year in germination and purity. Satisfactory germination of *Cynodon* seed was achieved only after scarification and that of cocksfoot was improved at alternating temperatures of 30° C. for eight hours and 20° C. for 16 hours. Scarification improved germination of indigenous clovers especially *Trifolium rueppellianum*. Early in the year the proportion of immature barley samples was high. These required retests after the conventional methods in soil. Samples of wheat and oats received shortly after harvest also showed delayed maturity and continued to germinate for a month or more when the tests were kept on. Other samples received for testing were sorghums, groundnut, cotton, rye, rice, buckwheat and wimbi from Kenya, and *Digitaria scalarum* from Uganda.

Fifty-eight collections of plant specimens were added to the Herbarium and a number of identifications were made by the East African Herbarium. *Emex australis* appeared in quantity on a farm in the Eldoret district. It was first found in a wheat sample sent to the laboratory. New apparatus installed in the laboratory during the year was an Ottawa Seed Blower, a "Circofreeze apparatus" and a new pattern of Copenhagen tank for connexion to the Circofreeze.

Blight-resistant Potatoes

The maintenance and multiplication of blight-resistant potatoes kindly supplied by Dr. Black has continued. The whole of the stocks were this year multiplied up at the Scott Laboratory. Twenty-three varieties were maintained in the collection and four varieties which had been selected as likely to be of value in the country were multiplied with the production of 74 bags in all. These four, E.52, K.52, C.53 and J.53, were distributed to 12 agricultural stations embracing a wide range of conditions. The object was to select suitable varieties for distribution among African growers. Similar collections were supplied to eight European farmers all of whom held farms in suitable areas for seed production and who had expressed the intention of specializing in high quality seed production for export. The following potatoes imported in 1955 were grown for further observation and multiplication:—Ulster Dale, Ulster Emblem, Chancellor, Record, Orion, and Craig's Alliance. Chancellor and Craig's Alliance suffered severely from Blight. No new varieties were imported from the United Kingdom during the year. A collection was made of some of the potatoes which have been grown in African areas for many years and whose identity has been lost. Nine collections came from the Taita Hills, three from the Director of Agriculture, Nyasaland, and one from Nyanza. This is a reintroduction of the collection of varieties which

was maintained in the early '40s. Skerry Blue was added to the collection again from a local market. During the "short rains" 43 varieties were grown in the experimental cage. A full crop was obtained from these following the abnormal rains of the period. Dutch Robijn introduced in 1946 continues to enjoy the position of being the most popular and widely grown potato in the Colony.

Legume Inoculants

During the year 252 orders were received for 1,940 units each sufficient to inoculate 20 lb. of small or 40 lb. of large seed: of this inoculant 40 per cent was for lupins, 13 per cent for lucerne, 12 per cent for various clovers and 35 per cent for miscellaneous legumes including beans, soya, peas and various tropical and local legume species. Fifty-eight per cent of these orders were from farmers and 21 per cent from Government Agricultural Stations in Kenya. Requests for cultures from other countries were from Tanganyika, Uganda, Portuguese East Africa, Madagascar, Seychelles, Mauritius, Union of South Africa, Australia, the Philippines, Hawaii and the U.S.A. Most of these requests were for inoculants required for trials of indigenous Kenya legumes, following the distribution of seed from the Pasture Research Station.

Ninety-five nodulation and nitrogen fixation tests were done during the year in the routine testing of the stock cultures and new isolations. Successful nodulation and nitrogen fixation was achieved on the following species:—*Trifolium pratense*, *T. repens*, *T. alexandrinum*, *T. subterraneum*, *T. semipilosum*, *T. rueppellianum*, *T. tembense*, *T. steudneri*, *T. usambarense*, *T. burchellianum* var. *johnstonii*, *Medicago sativa*, *M. denticulata*, *Melilotus alba*, *Ornithopus sativus*, *Lupinus* spp., *Vicia* spp., *Pisum sativum*, *Lathyrus* sp., *Hedysarum coronarium*, *Teramnus labialis*, *T. uncinatum*, *Glycine maximum*, *G. javanica* and *Vigna gracilis*. Most of the tests made were on species of *Trifolium*. A start has been made on determining the cross-inoculation relationships within this genus. The indications are that the indigenous Kenya clovers form a separate group with full cross-inoculation within the group and no cross-inoculation with *Trifolium* species outside the group. Forty-two new strains were obtained during the year either from local isolations or from institutions abroad. The pot collection of plants carrying stock strains of Rhizobia has been continued and expanded and contains about 70 species of some 30 genera.

An improved technique for testing strain effectiveness in small seeded legumes has been evolved by the Plant Pathologist. An account of this technique has been accepted for publication in the *East African Agricultural Journal* under the title of (Robinson, R. A.) "Legume Inoculants: a Method of Testing Rhizobium Cultures."

R. M. NATTRASS,
Senior Research Officer (Plant Pathology).

ANNUAL REPORT OF THE SENIOR SOIL CHEMIST, 1956

METEOROLOGICAL

The following summarizes meteorological data obtained at the Scott Agricultural Laboratories during 1956:—

MONTH	TEMPERATURES °F.				RAINFALL		SUNSHINE	
	Absolute		Mean		Inches/Days		Hours	Days
	Max.	Min.	Max.	Min.				
January	78·8	49·9	73·1	55·2	5·56	19	203·0	6·55
February	80·6	50·1	76·8	55·5	2·60	8	272·6	9·40
March	81·8	53·0	77·5	57·2	3·04	11	257·5	8·31
April	79·4	55·5	75·7	57·6	6·32	12	192·8	6·43
May	78·2	53·6	73·5	56·1	2·59	13	151·2	4·88
June	75·5	47·5	71·3	53·2	0·64	5	133·1 (1)	4·59 (1)
July	76·2	45·0	69·8	50·4	0·73	6	116·6 (1)	3·89 (1)
August	79·5	45·0	71·4	51·3	0·42	5	150·3 (1)	5·01 (1)
September	82·0	45·0	73·4	52·1	0·66	4	137·4	4·58
October	82·1	50·0	77·4	54·5	1·21	5	206·8	6·67
November	76·6	54·0	72·0	55·8	3·87	19	155·8	5·19
December	77·0	51·9	73·4	55·1	0·92	9	238·2 (1)	7·94 (1)
Year	82·1	45·0	73·8	54·5	28·56	116	2,215·3 (1)	6·10 (1)
Over 31 years ..				mean	36·61			
Over 6 years ..	90·0	40·1	74·8	55·0		mean	2,304·0 (1)	6·44 (1)

The total rainfall for 1956 was again well below average and an abnormally large proportion of the rain which did fall fell in January and February and was of no use to seasonal crops. However, the Long Rains though light suited early planting in their distribution and brought through a quite good crop of maize. The Short Rains were well spread and got the season's crop of beans away to a good start. The rainfall distribution favoured good grass growth but was troublesome at harvesting.

Fertilizers and Fertilizer Studies

Fertilizer studies in African lands were intensified, new exploratory trials being laid down in the Long Rains at 113 sites in Nyanza, Central and Southern Provinces. Sites were located and the crops to be tested, the methods whereby they were to be grown and the fertilizer treatments they were to receive were chosen in consultation with interested officers in the field services. A simple 2⁴ factorial design with confounding of the third order interaction and a block size of eight plots was adopted for all trials, each trial being made up of 48 plots in three complete replicates. The aim in laying down each trial was to locate it in a compact geographical area (usually an Administrative Division) on a crop and in a soil/climate/vegetation zone of major importance in that area. As uniform and as typical sites as possible were selected and differences between site characteristics were taken up in the groupings of blocks into replicates. By ringing the changes on crops and environments from area to area we sought to cover as wide as possible a range of crops and of conditions under which they are grown and to obtain indications of the geographical validity of the results of the trials. In all trials where beans and field peas were used the fertilizer treatments covered 40 per cent superphosphate and muriate of potash at 1 cwt./acre: where maize, sorghum and millet were used, sulphate of ammonia at 1 cwt./acre was also included and where potatoes were used all three fertilizers were tested at double these rates. In areas where evidence existed of the likelihood of liming being desirable the fourth factor was taken up by liming at rates determined by laboratory investigations. Elsewhere FYM

application at 15 tons/acre for potatoes and at half this rate for the other crops was adopted. All sites were reviewed after establishment of the Long Rains crop and as a result a number of them were abandoned and replaced by new sites for the Short Rains crop. Furthermore, the cropping of the replicates was varied with the object of extending exploratory investigations to cover residual effects and crop sequence. Other than in Kangundo Division the rains in both seasons in all parts of Southern Province failed and very little information came out of the trials. In Kangundo, in South Nyanza and most areas of Central Province the trials in both seasons were carried through successfully to harvest and while the results remain to be analysed the anticipated responses to phosphate have been widespread. Potatoes was the crop tested which showed the greatest response to the fertilizer treatments. In Central Nyanza, North Nyanza and Elgon, the intricacy of the soil pattern led to much less satisfactory selection of sites. Furthermore, the trials themselves fared rather poorly. In consequence, at relatively few sites were the trials successful and could they be carried through to residual studies in succeeding seasons. (The material for the above paragraph on exploratory fertilizer trials in the African land units was contributed by Mr. Boswinkle.)

The complementary rates trials were continued and the following information additional to that tabulated in 1955 can now be presented:—

Centre Altitude and Soil	Season Rainfall during growth Yield units	Crop Fertilizer Treatment	Level	YIELD DATA (LB./ACRE) FERTILIZER		
				N	P	K
Shimba Hills 800 ft. Pallid acid sand of low fertility.	To L.R. 1955, <i>see</i> Annual Report 1955. S.R. 1955 9.79 in. lb./grain/acre	Green gram Residual	0	458	237	341
			1	350	405*	406
			2	358	524**	417
	L.R. 1956 23.66 in. lb./grain/acre	Local white maize N & K reapplied	0	1,617	1,217	1,739
			1	1,590	1,992***	1,533*
			2	1,754	1,767***	1,699
Embu 4,800 ft. Kikuyu dark red loam.	To L.R. 1955, <i>see</i> Annual Report 1955. S.R. 1955 11.64 in. lb./grain/acre	Boston beans Residual	0	478	441	526
			1	476	512*	498
			2	570**	570**	500
	L.R. 1956 32.09 in. lb./grain/acre	Maize under sown grass. P and double rate N reapplied	0	1,110	negative N.K.*	
			1	1,964**	1,097	—
			2	1,888**	1,685*	—
			2	1,888**	2,180**	—
Kisii 5,600 ft. Kisii red loam.	L.R. 1954 45.76 in. lb./grain/acre	Maize N & P applied.	0	1,948	1,502	—
			1	1,766	1,908*	—
			2	1,988	1,994*	—
			3	1,956	2,258*	—
Sotik Experiment Station 6,000 ft. Red loam.	L.R. 1955 30.19 in. lb./grain/acre	Maize N & P applied	0	No	3,536	—
			1	significant effect	4,794**	—
			2		5,160**	—
	L.R. 1956 36.03 in. lb./grain/acre	Maize Residual	3		4,992**	—
			0	2,898	2,620	—
			1	2,860	1,864	—
			2	3,016	3,616	—
			3	2,330	2,998	—

NOTES—

- (1) *, ** and *** indicate significant yield differences from the corresponding nil fertilizer level yield at the 5 per cent, 1 per cent and 0.1 per cent points respectively.
- (2) Levels 0, 1, 2 and 3 of N and P at Kisii and Sotik correspond with 0, 0.48, 0.96 and 1.44 cwt./acre of sulphate of ammonia and double supers respectively. Single rate levels elsewhere correspond with 0, 1 and 2 cwt./acre each of sulphate of ammonia and double supers and 0, $\frac{1}{2}$ and 1 cwt./acre of muriate of potash. The double rate of N application corresponds with 0, 1 and 2 cwt./acre sulphate of ammonia applied to the seed bed and again as a top-dressing. The double rate of N application apart, all fertilizers were given to the seed bed.
- (3) Apart from the NK interaction at Embu in S.R. 1955, no significant interactions were recorded.

The importance of phosphates on normal red loam soils and their strong residual effects on phosphate-responding soils are again apparent, highly significant residuals now being reported into the third season at Shimba Hills and the sixth season at Embu. Similarly strong phosphate residuals have also been reported from other phosphate-responding centres.

The benefits at Embu from sulphate of ammonia split between seed bed and top-dressing in contrast to its ineffectiveness as a single seed bed application was confirmed.

In a further comparison undertaken on the Eldoret Experimental Farm the cumulative effects of double supers, soda phosphate and Uganda Rock phosphate over a period of 3 years of application and their residuals are being studied. Treatment particulars and yield effects so far are:—

TREATMENTS	YIELD LB./ACRE IN			
	1952 (Wheat)	1953 (Wheat)	1954 (Barley)	1955 (Wheat)
No phosphate applied	811	52	570	104
816 lb./acre Uganda Rock Phosphate applied in 1952 only	957**	94	841***	169*
In 1952 and again in 1953	—	56	911***	215***
In 1952, 1953 and 1954	—	—	944***	298***
466 lb./acre soda phosphate applied in 1952 only	1,145**	143*	867***	209***
In 1952 and again in 1953	—	181***	1,095***	279***
In 1952, 1953 and 1954	—	—	1,301***	347***
200 lb./acre double supers applied in 1952 only	1,262**	154**	910***	219***
In 1952 and again in 1953	—	240***	1,091***	319***
In 1952, 1953 and 1954	—	—	1,268***	377***

The total yield effects to date are summarized:—

TOTAL YIELD OVER YIELD PERIOD					
YIELD PERIOD	No Phosphate	PHOSPHATE APPLIED AS			Year of Phosphate Application
		U.R.P. at 816 lb./acre	Soda Phosphate 466 lb./acre	Double Supers 200 lb./acre	
1952-55 ..	1,537	2,061	2,364	2,545	1952
1953-55 ..	726	1,104	1,219	1,283	1952
	—	1,182	1,555	1,650	1952 and 1953
1954-55 ..	674	1,010	1,076	1,129	1952
	—	1,126	1,374	1,410	1952 and 1953
	—	1,242	1,648	1,645	1952, 1953 and 1954
1955	104	169	209	219	1952
	—	215	279	319	1952 and 1953
	—	298	347	377	1952, 1953 and 1954

All three forms of phosphate were beneficial in the year of application and have produced significant residual effects extending for at least three years thereafter. Each year both the direct and the residual effects of the double supers and soda phosphate application have proved to be far greater than the corresponding effect of the U.R.P. dressing. The differences between the fertilizers in the residual years in all cases are smaller than in the year of application. Repeated application of both the soda phosphate and double supers usually was more effective in obtaining progressive yield increases than repeated application of the U.R.P. Similar results were obtained in a comparative study of U.R.P., soda phosphate and double supers undertaken at Scott Agricultural Laboratories between 1948 and 1952, and discussed in the 1952 Annual Report. The great superiority of the soda phosphate and double supers at Eldoret in the year of application is attributable to the placement of these fertilizers at sowing and to their high early availability to the crop. Their continued superiority in residual years once more suggests that they are held in the soil in forms which are more available to plants than the forms in which phosphate is held in Uganda Rock Phosphate. Though these conditions may not be reflected in the citric acid solubility tests mentioned in the 1952 Report, there is growing evidence that the application of citric acid and water soluble phosphates actually does lead to an increase in easily extractable soil phosphate. In particular Stelly (Report on Technical Assistance Project No. 57-119: Maintenance of Soil Fertility: Table V) reports N/21 H_2SO_4 extractable phosphate figures for two soil comparisons (samples 16, 19, 36 and 41) clearly indicating an increased phosphate availability (corresponding with a rise from the Beater "very low/low" to "low/medium" ranges) resulting from the repeated phosphate application which would go with prolonged arable cultivation on phosphate deficient soils in the Kenya Highlands.

The aim in the Eldoret trial was to apply double supers and soda phosphate at the same rate (84 lb./acre per application) of citric soluble P_2O_5 /acre. Where this was achieved (from 1953, onwards) there was no material difference between the effects of these fertilizers. However, the citric soluble P_2O_5 content of the soda phosphate applied in 1952 was sub-normal, and in consequence the rate of citric soluble P_2O_5 applied that year as soda phosphate was less than that applied as double supers; this being reflected in the yield data for 1952 and its residuals. The situation was adjusted, where repeated applications were given, by giving a supplementary soda phosphate dressing in 1953 to the soda phosphate plots concerned.

The economics of the application over the four years of the trial are readily determinable.

Forms of Phosphate Trials, 1955/56

In certain phosphate-responding areas, new comparisons have been made of the effectiveness of different phosphatic fertilizers likely to be of interest to the farming community. In these trials an attempt was made to express the value of single supers, soda phosphate, basic slag and North African rock phosphate in terms of "double supers equivalence", following the technique developed by Crowther, Warren and Cooke. (The Agricultural Value of Alternative Phosphatic Fertilizers Other Than Silico Phosphate: Part II. Field Experiments. *Permanent Records of Research and Development*, No. 11. 109, Ministry of Supply, London, 1953.) Rates of application were based on 33 and 66 lb. of citric soluble P_2O_5 per acre as double supers, 66 lb. as single supers and 50 lb. in the case of each of the other fertilizers. Trials were carried through to harvest on wheat on Kinangop grey silt loam and on maize and young grass on Kitale red sandy loam. The results obtained are summarized:—

CENTRE AND CROP	No Phos- phate	33 LB.	66 LB.		50 LB.		
		CITRIC SOLUBLE P ₂ O ₅ /ACRE AS					
		Double Supers	Double Supers	Single Supers	Basic Slag	Soda Phos- phate	Rock Phos- phate
Kinangop: Wheat 1955, lb. grain/acre	336	647***	768***	774***	700***	594***	434
Per cent Efficiency	—	100	100	112	87	45	15
Double Supers equivalence	—	—	—	221	295	504	2,240
Wheat 1956, residual ..	149	147	148	139	152	138	141
Kitale: Maize 1955, lb. grain/acre	2,140	2,367**	2,472***	2,220	2,296**	2,438***	2,488***
Per cent Efficiency	—	100	100	(20)	41	112	171
Double Supers equivalence	—	—	—	(1,816)	631	202	197
Kitale: Grass tons green matter/acre first cut 15-17 9/55	4.35	11.18***	11.25***	11.16***	8.08**	9.36***	7.14*
Subsequent cuts 10/11/55	6.16	2.46***	2.76***	2.07***	5.00	3.60***	4.95
11/1/56	0.73	1.06	1.08	1.15	1.26*	0.97	0.81
3/4/56	0.50	0.46	0.56	0.56	0.56	0.56	0.45
18/5/56	2.09	1.92	2.04	1.89	2.06	1.77	1.96
31/7/56	0.87	0.82	1.00	0.86	0.89	0.76	0.88
19/10/56	0.42	0.49	0.54	0.55	0.53	0.42	0.51
4/2/57	0.12	0.14	0.17	0.15	0.15	0.13	0.16
Total 4th-8th cuts ..	4.00	3.83	4.31	4.00	4.19	3.64	3.94
Total post establishment cuts	10.89	7.35***	8.15**	7.23***	10.45	8.21**	9.72
Total all cuts	15.24	18.55**	19.37***	18.38**	18.52**	17.57*	16.83
Per cent Efficiency—							
First cut	—	100	100	49	6	10	4
All cuts	—	100	100	44	65	36	21
Double Supers equivalence							
First cut	—	—	—	503	4,061	2,377	8,190
All cuts	—	—	—	528	398	606	1,585

NOTE.—Yields marked * are significantly different from the no phosphate yield at the 5 per cent point, ** at the 1 per cent point, and *** at the 0.1 per cent point.

The per cent efficiency of each fertilizer is the effectiveness of its citric soluble P_2O_5 content in terms of the citric soluble P_2O_5 content of the double supers used and is the number of pounds of citric soluble P_2O_5 as double supers by calculation producing the same effect as 100 lb. citric soluble P_2O_5 as the fertilizer.

The double supers equivalence of each fertilizer is the number of lb. of that fertilizer which, by calculation, needs to be applied to produce the same effect as 100 lb. of 42 per cent superphosphate.

The equivalences are calculated on the basis of the following Mitscherlich response curves which fit the no phosphate/double supers treatments data:—

$$\text{Kinangop Wheat } Y = 845 - 509 \times 10^{-0.0123x}$$

$$\text{Kitale Maize } Y = 2530 - 390 \times 10^{-0.0116x}$$

where Y is the yield in lb. of grain per acre which is obtained from the application of x lb. citric soluble P_2O_5 per acre as double supers.

Kitale Grass:—

$$\text{First cut } Y = 11.25 - 6.90 \times 10^{-0.055x}$$

$$\text{All cuts } Y = 19.64 - 4.40 \times 10^{-0.0184x}$$

where Y is the yield in tons of green matter per acre.

The citric solubilities of the fertilizers used and the rates at which they were applied are:—

FERTILIZER	Citric Soluble P_2O_5 per cent	Rate of Application lb. per acre	Giving lb. Citric Soluble P_2O_5 per acre
Double Supers	40.6	{ 82	33
Single Supers	16.9	164	66
Basic Slag	16.3	395	66
Soda Phosphate	18.5	306	50
North African Rock Phosphate ..		271	50
(Hyperphosphate Reno) ..	12.5	400	50

In the year of application, on a citric solubility application basis, basic slag was roughly as effective as double supers on wheat on the Kinangop soil. Soda phosphate application gave a yield increase also, but it was markedly less effective, while North African rock phosphate produced no significant benefits. There was no measurable residual effect from any of the fertilizers in the year after application.

On maize on the Kitale soil, North African rock phosphate was the most effective of the fertilizers tried and soda phosphate performed roughly as well as double supers. Basic slag was noticeably less effective, while single supers inexplicably was not significantly beneficial.

On Nandi *Setaria* grass on the Kitale soil, establishment was best where the superphosphates were used, the effectiveness of single supers being not significantly different from that of doubles. The other forms of phosphate tried were strikingly less effective. The high yielding treatments suffered a severe check at the first cut and had not recovered from it at the time of the second cut, the result being that all phosphate treatments yielded less than control, the depression of yield being highly significant in the case of the superphosphates and the soda phosphate treatments. This yield depression in the second cut is reflected even in the post establishment cut totals. All the forms of phosphate tried helped to extend production into the dry season and produced some yield increase at the third cut, though significance was attained only with basic slag. From the fourth cut onwards none of the fertilizers had a measurable effect on the grass yields. Over all cuts, double supers was the most effective of the forms of phosphate. Yield levels fell off badly as the new ley ran into its first dry season and recovered only to a limited extent in the next long rains, the effect being a much lower level of production at all cuts in 1956, followed by even lower production during the second dry season. Particularly in the establishment cut, the response of the grass to double supers fell off markedly more quickly with increasing rates of phosphate application than the grains, the yield effect of the higher double supers level being little greater than the lower. Consequently, the precision of the per cent efficiency and the double supers equivalence data is lowered: for a more precise estimate, a re-examination using a lower range of double supers levels will be necessary.

The recent observation at the Grassland Research Station on the need of legumes and other forage plants at Kitale for sulphur seems not to apply to Nandi *Setaria* or to maize, for on neither of these crops was the single supers treatment (carrying with it an application of nearly 200 lb. per acre calcium sulphate) as effective as the same phosphate application as double supers (carrying with it very little application of calcium sulphate).

Forms of Nitrogen Trials

Trials of forms of nitrogenous fertilizer likely to be of interest to farmers on nitrogen-responding crops in nitrogen-responding areas were also undertaken. The only available results concern newly established grass at Kitale and these are:—

CENTRE AND CROP	No Nitro- genous fertilizer	18 LB.	27 LB.					
		NITROGEN PER ACRE AS						
		90 lb. Sulphate of Ammonia	180 lb. Sulphate of Ammonia	180 lb. Nitrate of Soda	130 lb. Calcium Cyan- amide	130 lb. N.A.C.	60 lb. Urea	
		<i>per acre</i>	<i>per acre</i>	<i>per acre</i>	<i>per acre</i>	<i>per acre</i>	<i>per acre</i>	
Kitale grass cwt. dry matter/acre—								
First cut ..	7.7	9.4*	14.6**	11.9**	7.8	10.9**	11.6**	
Second cut ..	7.9	11.0*	10.3	9.0	7.8	9.3	8.8	
Total	15.6	20.4*	24.9**	20.9**	15.6	20.2*	20.4*	
Per cent Efficiency ..	—	100	100	73	0	59	67	
First cut—								
Yield of crude pro- tein lb./acre ..	57.82	78.71	110.90**	96.99**	54.63	94.44**	76.62	
Yield of Phosphorus in Herbage lb./ acre	3.27	3.48	5.48**	5.27**	3.25	4.79*	4.18	

(Analyses by Dr. H. W. Dougall)

NOTE.—* and ** indicate yields which differ significantly from the corresponding no nitrogen yield at the 5 per cent and 1 per cent points respectively.

The per cent efficiency of each fertilizer is the number of lb. of nitrogen as sulphate of ammonia which by calculation would produce the same response over the two cuts as 100 lb. as the fertilizer and is a measure of the effectiveness of its nitrogen content in terms of the nitrogen content of sulphate of ammonia. It is calculated on the basis of the Mitscherlich response equation

$$Y = 92.5 - 76.8 \times 10^{-0.00158x}$$

where Y is the yield of dry matter in cwt./acre obtained from an application of x lb. nitrogen/acre as sulphate of ammonia, which fits the no nitrogen/sulphate of ammonia data for the total of both cuts.

Patently, the grass showed no measurable response to the calcium cyanamide application at either cut. The early effects of nitrate of soda and of urea were roughly the same as the sulphate of ammonia, whilst the N.A.C. was less effective. Persistence into the second cut of the effectiveness of nitrate of soda, urea and N.A.C. was noticeably less than that of sulphate of ammonia and this accounts largely for their relative inferiority over the cut totals. The yields of crude protein and of phosphorus in the herbage harvested in the first cut followed closely the dry matter yields, all nitrogenous fertilizers other than calcium cyanamide producing increases, the increases being significant in respect of both constituents for the nitrate of soda, the N.A.C. and the heavy sulphate of ammonia treatments. It seems that the grass is somewhat less able to forage for phosphate and to convert nitrogen into crude protein when N is applied as urea than when it is applied in the other forms. The nitrogenous fertilizers had no consistent effect on the crude protein or phosphorus content of the herbage. The exceptionally high yield of the heavy sulphate of ammonia application treatment in the first cut, and the slight setback indicated in the second cut suggests that this treatment received a slight check at the first cut.

The trial on maize at Kitale suffered damage during growth and produced no discernible response pattern to the applied nitrogenous fertilizers.

Lime/Fertilizer Experiments

(Dr. L. A. Whelan)

The liming trials at Kaptagat, Eldoret, Marindas and Kinangop were continued and further parallel laboratory studies undertaken.

At Kaptagat in the 1955 wheat planting all phosphate treatment applications showed highly significant increases of 479–694 lb./acre over control yields of 324 lb./acre and P_3 was significantly better than P_1 . All lime applications showed highly significant increases of 637–847 lb./acre over control yields of 174 lb./acre but no significant differences among treatments. The interactions between phosphate and lime were positive and highly significant, and growth failed entirely on those plots which received neither lime nor phosphate. Highly significant phosphate responses but no significant lime responses have been recorded each year previously on this site. On the other hand, observations on the 1956 crop of wheat promise that production from the limed land will be much less than from the unlimed land! Unlike previous years, the potash application in 1955 had no significant effect on yield while nitrogen produced striking benefits, particularly on the land which has received heavy dressings of phosphate. The nitrogen effect may be due to the ploughing in of the heavy crop of straw from the phosphate-treated plots of the preceding crop. Both lime and phosphate application led to an increase in grain weight and nitrogen application to a decrease while potash had no effect.

At Marindas in the 1955 wheat planting, liming led to small non-significant yield increases of 68–112 lb./acre over control yields of 867 lb./acre: the lime effect is much smaller than that observed in 1954, the year of application. Phosphates produced highly significant increases of 443–891 lb./acre over control yields of 437 lb./acre, P_2 being superior to P_3 particularly when associated with liming. The NK application had no significant effect. Phosphate again produced an increase in grain weight, the NK mixture brought about a similar increase while the lime application produced a decrease.

At Kinangop the 1956 wheat crop was badly infested with volunteer barley from the 1955 crop and a mixture of barley and wheat was harvested, barley being predominant just before harvest on the limed land and wheat on the unlimed. Phosphate application again produced marked yield increases of 228–369 lb./acre over control yields of 720 lb./acre, higher yields being obtained at P_2 than at P_3 . Lime application produced yield increases of 121–204 lb./acre over control yields of 850 lb./acre. NK produced no response. The plots in 1956 were split with a view to comparing carting-off the straw from the preceding crop with ploughing it in: the effect was negligible at the levels of NPK and lime covered by the trial, even though the weights of straw involved were large.

The exchangeable bases studies by the Mehlich technique were extended to samples collected from the Eldoret trial in January, 1956. The results obtained are summarized:—

COMPONENT	TREATMENT			
	L ₀	L ₁	L ₂	M
Per cent saturation ..	32	44	56	45
pH	5.1	5.9	6.3	6.0
Ca me per cent	3.8	6.6	7.9	7.1
Mg me per cent	2.7	2.8	3.1	2.3
Ca/Mg	1.4	2.4	2.6	3.1
	no N or K	K	N and K	
K me per cent	0.65	0.90	0.90	—

The Ca/Mg ratio was widened and the per cent saturation, exchangeable Ca and pH were greatly increased by the limestone application, the increases being in step with the levels of application. Exchangeable Mg was increased slightly by the dolomitic limestone and decreased by the calcitic limestone. Exchangeable K showed a considerable increase following three annual applications each of 200 lb./acre muriate of potash.

Leaf samples taken from just before full flowering of the 1954 wheat crop at Eldoret were also examined. Neither the P nor the Ca nor the Mg content of the leaves was much influenced by the lime or the phosphate application. The only marked effect observed was a progressive depression of Si as a result of phosphate application. This was observed also in a more restricted study on Kaptagat samples. Potash application led to an appreciable increase in K and Si in the leaves and to striking depressions both in Ca and Mg.

Soil Surveys

The Mwea/Tebere topographical maps became available early in the year and land use maps covering the 76,000 acres surveyed in 1955 were prepared for the guidance of the engineers and management of the scheme. The bulk of the soil samples collected during the survey are now under laboratory examination. However, experience in the field supports the chemical indications now available that major salinity/alkalinity hazards are unlikely to be encountered. The field sampling of the Tana Delta project was also completed but, pending the results of further investigations near Hola of the potentialities of the Desert Hinterland, work on them is in abeyance.

Irrigation

A scheme was drawn up and the necessary structures were installed near Hola for investigating the possibilities of reclaiming the salted soils in the Desert Hinterland of the lower River Tana. In addition, a series of observation plots was laid down to determine the possibilities of crop production there without prior reclamation treatment. Growth on these plots, on the whole, proved better than expected and in consequence development possibilities are considered rather bright. However, continued investigation of reclamation needs is still considered desirable and is being undertaken.

The establishment of an irrigation station to serve the potential irrigation areas of Nyanza Province still awaits a satisfactory settlement with local interests. Development of the Mwea Irrigation Station is well advanced.

Nitrogen in Rainfall Studies

Determination of the ammonia nitrogen content of rainwater collected at Scott Agricultural Laboratories was continued. The results from daily collections in 1956 were:—

MONTH	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall	5.56	2.60	3.04	6.32	2.59	0.64	0.73	0.42	0.66	1.21	3.82	0.92
Ammoniacal N added by rain:—												
lb./acre	.470	.590	.235	.254	.299	.027	.140	.081	.056	.395	.153	.004
lb./acre per inch of rain	.085	.227	.077	.040	.115	.042	.192	.193	.085	.326	.040	.004
lb./acre per inch of rain (mean over 7 years)	.103	.126	.103	.074	.078	.038	.095	.093	.103	.143	.093	.075

TOTAL ADDITION OF AMMONIACAL N:

lb./acre 2.704

lb./acre per inch of rainfall .095

lb./acre per inch of rainfall (mean over 7 years) .082

While there is considerable variability in the data, the June content is consistently lower than the other months, the difference from January, February, March, May and July contents being significant on the basis of direct month by month comparisons over the years.

Bioassays

(Mr. B. Butters)

The examination of soil nutrient deficiencies by pot culture techniques was continued, particular attention being paid to the possibilities of the Webb technique (*Trans. V Congress Soil Science*, 1954, III, 214-217, and *Proc. Second Inter-African Soils Conference*, 1954, I, 417-424) as modified by Chenery (mimeographed unpublished communication, 1955) in this direction, tomatoes being used as the test crop.

Six soils were examined from areas of poor crop performance, details being:—

Lab. Ref. No.	Laboratory Description	Field Behaviour
708/55	White Lesirko	Poor performance of Lucerne under irrigation.
2941/55.. ..	Vet. Labs. top	Poor growth of Legumes; failure of pasture to respond to fertilizers.
2942/55.. ..	Vet. Labs. bottom..	
2943/55.. ..	Pyrethrum Stn. Marindas..	Suspected Molybdenum deficiency.
2944/55.. ..	Hill, Nakuru	Copper deficiency area.
2945/55.. ..	Nicholson, Subukia	Low yields of most field crops.

The assay involves determining the dry matter production of a test crop growing in the test soil in a medium lacking only a single nutrient element, in terms of the percentage of the dry matter production in the presence of a full nutrient solution. A full test covering four replicates of deficiencies in the nutrients N, P, K, Ca, Mg, Mn, Cu, Zn, Mo, S, B and Cl with two extra curricula tests is conveniently carried out in a 64-pot trial and this is the unit which has been tentatively adopted.

On the Nicholson soil, prior to liming, no plant made satisfactory growth. As the pH value of this soil (5.2) and its calcium status (3.7 me per cent) indicated a rather intense level of acidity and poor base status, a subsidiary trial was then undertaken in which the effect of liming to half and full theoretical lime requirement in the presence and absence of complete nutrient was investigated. The following two-way table shows the yields obtained in terms of mgms dry matter produced by tomatoes during the growing period of six weeks:—

	YIELD: MGM. DRY MATTER PER PLANT		
	With nutrient	Without nutrient	Mean
No lime	6.2	25.3	15.7
Limed to half lime requirements..	12.6	97.4	55.0
Limed to full lime requirements (2.90 tons/acre)	13.6	139.3	76.4
Mean	10.8	87.3	—
Least difference for significance:	body of table	lime means	nutrient means
5 per cent	80.4	56.7	46.5
1 per cent	111.2	78.7	64.2

More Nicholson material has since been collected and a complete nutrient assay has been applied to samples which have been limed to full lime requirement. On this material no lime response was recorded and the only important nutrient deficiency was of phosphate! The results obtained on the other soils examined and the supporting laboratory data are:—

TREATMENT	708 White Lesirko	2941 Vet. Labs Top	2942 Vet. Labs Bottom	2943 Pyrethrum Marindas	2944 Hill's Njoro	2945 Nicholson Subukia
Complete Nutrient ..	100	100	100	100	100	—
Nil	21.2***	(1) 8.6***	(1) 9.2***	(1) 4.9***	(1) 9.0***	—
Complete—						
—N	115.1	101.1	86.3	93.7	107.2	—
—P	27.1***	(1) 10.5***	(1) 11.3***	(1) 4.3***	(1) 10.5***	—
—K	87.0	99.3	79.5	78.6	118.8	—
—Ca	92.1	102.9	90.2	99.7	103.2	—
—Mg	84.1	104.7	69.8	103.5	106.1	—
—Mn	119.1	97.3	91.6	74.6	107.6	—
—Cu	79.6	94.4	90.8	83.8	(2) 55.2*	—
—Zn	106.4	105.5	87.9	55.0*	75.5	—
—Mo	87.8	103.5	69.5	(3) 43.3**	112.0	—
—S	97.5	104.6	(4) 49.3*	100.8	111.5	—
—B	96.7	111.6	82.3	100.6	119.0	—
—Cl	111.1	103.7	94.0	82.5	113.8	—
Extra-curricula: Complete nutrient—						
Lime applied	—	70.9**	56.4	—	102.0	—
Lime withheld	88.9	—	—	102.3	—	—
Plus Fe	67.0	118.0	75.2	(3) 50.5**	108.1	—

Production level, as percentage of production in presence of complete nutrients below which nutrient deficiency is significant at:

5 per cent Point	59.8	78.9	51.8	67.6	65.8	—
1 per cent Point	45.9	71.5	35.6	56.9	54.2	—
0.1 per cent Point	29.3	61.4	15.6	43.6	40.0	—
Analytical data—						
pH	5.0	6.6	—	4.8	—	5.2
Organic C per cent	4.2	5.2	3.1	3.6	4.2	1.6
N per cent	.45	.45	.25	.33	.39	.13
Exchangeable Bases me per cent—						
Capacity	21.2	31.3	21.0	22.2	22.3	15.0
K	1.54	3.94	2.30	1.93	3.62	1.29
Ca	7.71	18.2	10.2	6.31	11.8	3.7
Mg	4.15	5.19	4.04	4.17	3.27	0.83
Lime requirement: tons/acre	2.32	—	—	3.14	—	2.90
Available P ₂ O ₅ ppm (Beater)	31	16	6	5	11	7

NOTE.—*, ** and *** indicates significant depression from the complete nutrient yield at the 5 per cent, 1 per cent and 0.1 per cent points. (1) indicates visual symptoms of P deficiency on plants, (2) ditto Cu, (3) ditto Mo, (4) ditto S.

On account of their high acidities the Lesirko (708) and Marindas (2943) assays were undertaken on soils which had previously been limed to half their lime requirement. For comparison an extra-curricula "lime" treatment in which complete nutrients were provided on unlimed samples was included. The other soils were assayed without a lime addition but an extra-curricula "lime" treatment was added in which complete nutrients were provided on samples in which 1 per cent calcium carbonate had been incorporated. The second extra-curricula set of treatments aimed to examine the possibilities of incorporating iron in a chelated form in the nutrient studies, this treatment being designated "complete plus Fe".

The major and most highly significant deficiency in all five soils assayed was of phosphorus, growth in the absence of phosphates alone being in all cases as poor or nearly as poor as in the absence of all nutrients. The scale of phosphate responses is in good accord with the indications of phosphate availability obtained chemically by the Beater method (*Plant and Soil* 1, (49) 215-220). Deficiencies of sulphur in the Veterinary Laboratories bottom land (2942), of zinc and molybdenum at Marindas (2943) and copper on Hill's (2944) were sufficient also significantly to depress growth. The molybdenum deficiency at Marindas is of particular interest in view of the leaf analysis observations on samples of pyrethrum from Marindas which were made by the Government Chemist, Dar es Salaam on some material supplied to him by the Senior Pyrethrum Officer. The Pasture Research Officer, Marindas, has also recognized molybdenum deficiency as a factor in legume culture in the field there. The liming of the Veterinary Laboratories soils (2941 and 2942) led to a depression of growth attributable to nutrient immobilization as a result of overliming on already near neutral soils. Liming even the acid soils from Lesirko (708) and Marindas (2943) was not significantly beneficial.

The iron addition led to a highly significant depression of growth on the Marindas (2943) soil and was noticeably, if not significantly, harmful on the Lesirko (708) and Veterinary Laboratories bottom land (2942) soils. The growth depression on the Marindas soil (2943) was associated with visual molybdenum symptoms. That molybdenum has effects on iron nutrition in plants has been reported widely. This attaches special interest to the iron/molybdenum effect at Marindas if the observation is confirmed.

Preliminary technique studies on the use of *Aspergillus niger* for nutrient assays were undertaken.

Two soils in which prior investigation had established the existence of specific nutrient deficiencies and one highly productive soil with a rather wide K/Mg ratio were examined with a view to determining the extent to which nutrient deficiencies or ill-balance might operate through suppression of nitrogen mineralization. The examination comprised incubation of the soils after liming and adjustment of their respective deficiencies or ill-balance as treatments in factorial combination, with assessment of the nitrate and ammoniacal nitrogen liberated as the result of each treatment. The incubation technique adopted largely followed Cornfield (*J. Sci. Food and Agriculture* 3, (1952) 343), the incubation temperature being 28° C. and the period 21 days.

The results showed that soil factors which seriously reduce crop yields and those which affect the mineralization of soil organic nitrogen are not necessarily connected. Of the factors studied, the addition of 0.1 per cent calcium carbonate was the only treatment which had any highly significant effect and here the effect was just as apparent on a slightly acid as on an extremely acid soil. The accumulation of nitrate N and total mineral N during incubation with lime was, in fact, greatest on the most acid of the soils and least on the highly fertile soil. The addition of phosphate to even a highly phosphate-deficient soil led to a reduction from 4.2 to 0.3 ppm in the accumulation of ammoniacal nitrogen, with no accumulation of nitrate nitrogen. The addition of manganese without a corresponding addition of potassium in the presence of manganese and potassium deficiency also appears after liming to lead to some accumulation of ammoniacal N. The only ammoniacal N accumulation observed after adding calcium carbonate was on the extremely acid soil and even this accumulation amounted only to 8.1 ppm (compared with a loss of 3.7 ppm/N from the unlimed treatment). This particular ammoniacal N accumulation is attributable to the profound disturbance of micro biological and chemical conditions which occur when extremely acid soils are limed (to which Cornfield draws attention) and to lack of opportunity

in the incubation period for the activity of the organism which converted ammoniacal N to nitrate N to increase adequately to deal with the acceleration in ammoniacal N liberation. With the least acid soils ammoniacal N tended, if anything, to disappear during the incubation, the rate of disappearance not being influenced by the addition of lime. Adjustment of other deficiency conditions led to no accumulation of mineral N. Nitrite was found usually in negligible amounts, contents exceeding 0.5 ppm occurring only in a few of the treatment combinations on the extremely acid soil.

Wheat Quality

(Mr. H. C. Hodgson)

Preliminary work was begun on a project to examine wheat protein composition with reference to the decline in dough strength of locally grown wheats. Assembly of the special equipment required for this work is well advanced.

Analytical Data: Foodstuffs

(Mr. R. J. Kempton)

The following data obtained during 1956 are of general interest:—

PRODUCT	Moisture	Oil	Crude Protein	Fibre	Ash	
Blood meal	7.85-11.29 14.48	—	77.88-88.55 2.47	—	—	—
Cassava flour	—	0.27	—	3.05	3.42	—
Copra	12.97	67.9	—	—	—	FFA 1.16%
Copra cake	6.55-10.57	3.87-12.25	27.14-44.79	9.27-25.06	4.87-7.05	Sand .122-.147%
Cotton seed cake	10.59	19.42	11.24	45.64	2.37	—
Grenadilla seed	7.13-9.49	5.72-6.23	35.00-51.84	—	—	—
Ground nut cake	87.91	0.13	0.98	1.18	0.81	—
Ipomea lapidosa	5.38	12.98	70.88	—	—	—
Liver meal	—	—	—	—	—	—
Maize meal—						
Straight run	11.12-12.28	3.52-4.98	—	1.18-2.62	1.10-1.50	—
Granulated	10.46-11.91	3.16-5.05	—	0.90-1.49	1.02-1.48	—
Sifted granulated	11.33-11.90	2.79-3.41	—	0.58-0.82	0.92-1.10	—
Meat meal	7.46-7.90	8.40-8.74	57.09-61.08	—	—	—
Oats green	82.7	0.41	1.88	5.51	1.63	—
Oil Palm seed	15.9	22.7	—	—	—	Shell 65.9 Kernel 18.2
Papyrus	6.33-7.24	0.48-0.87	2.47-2.77	33.67-37.14	5.89-8.93	—
Rice bran	10.92	7.15	10.75	10.57	12.98	—
Rice dust	9.40	2.88	7.63	17.12	8.00	—
Rice meal	12.67	1.54	5.61	8.22	6.56	—
Russian Comfrey	2.34-12.29	1.16-2.83	14.42-26.75	6.92-10.13	7.45-41.82	—
Russian Comfrey—						
Shade dried	10.00	2.79	23.13	9.84	22.31	High ash values.
Tray dried	Per cent of dry matter	3.66	26.06	11.61	21.53	are due to soil splash on
Unshredded		2.22	23.14	12.11	28.37	to lower leaves
Shredded		3.74	24.22	14.70	23.96	
Roof dried:		2.64	22.47	13.03	24.46	
Unshredded						
Shredded						
Silage—						
Grass	80.2	—	1.20	—	—	pH 5.4
Lucerne	71.8	1.24	5.03	7.61	3.10	—
Maize	74.7-86.3	0.44-0.65	1.31-1.79	5.48-5.62	0.57-1.64	pH 5.2-6.6
Oats	35.6	0.17	1.51	4.90	1.74	—
Oats cut at 10 weeks	82.7	0.41	1.79	7.11	2.61	pH 5.2
Oats cut at 14 weeks	83.0	0.43	0.82	7.13	2.25	pH 5.4
Sisal Waste—						
Dried	15.6	1.9	3.2	29.2	6.7	—
Fresh	84.3	0.3	0.6	3.6	1.6	—
Sunflower bran	12.65	9.17	9.88	29.63	6.99	—

The maizemeal samples were analysed with a view to establishing legal standards for the definition of the respective grades.

Analytical Data: Fertilizers and Manures

(Mr. R. J. Kempton)

MATERIAL	Moisture Per cent	N Per cent	P ₂ O ₅ Per cent	K ₂ O Per cent	CaO Per cent	MgO Per cent	
Bat Guano ..	24.12	5.78	6.41	—	—	—	
Compost, air dried ..	2.08-	0.64-	0.38-	0.17-	—	—	
	9.0	1.55	1.90	1.09	—	—	
Deep litter ..	13.3	2.03	3.22	1.54	—	—	
Floculated lime ..	0.01	—	—	—	66.2	2.8	Acid in sol. 1.88 Sesquioxide 3.40
F.Y.M. ..	57.5-	0.73-	0.37-	1.76-	—	—	
	63.8	0.74	0.47	1.96	—	—	
Limestone ..	—	—	—	—	48.0	10.9	
Old Mushroom bed ..	7.53	0.84	0.47	0.13	—	—	Ash 31.6
Poultry manure ..	47.8	2.09	1.61	1.08	—	—	
Seychelles Guano ..	5.7-	—	21.95-	—	—	—	
	14.02	—	29.1	—	—	—	
Soda phosphate ..	0.65	Total citric soluble	23.69 18.0- 19.2	—	—	—	

The majority of the soda phosphate samples were analysed as a result of a request to investigate and to assist the local manufacturers in maintaining the standard of their product. None of the samples, whether received from farms or collected at the factory, had a citric soluble P₂O₅ content below that guaranteed by the manufacturers. This is the result of the much more stringent production control maintained at the factory and improvement in manufacturing technique.

Bush and Weed Control

In collaboration with the Agricultural Officer, Ol Joro Orok, a trial was started at Cedarville Farm, Nanyuki on the association of controlled burning and grazing with the use of growth regulator herbicides for the eradication of *Euclea divinorum*.

Publications

Gilgai Phenomena In Tropical Black Clays of Kenya. I Steven, E. Bellis and A. Muir: *Journal of Soil Science*, 7, (1956) 1-9.

E. BELLIS,
Senior Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER, 1956

I—General

The season started off by being very wet at planting in May and June followed by dull, cold and sunless weather with excessive rain during July to September. This held the wheat crop back for a considerable period, but with the advent of warmer weather in October a good recovery was made and average yields have been obtained.

The monthly rainfall totals at Njoro were as follows (this distribution reflects the general picture in the country):—

RAINFALL (INCHES)

MONTH	1956	27 years' average
January	3.57	0.95
February	1.94	1.29
March	3.20	2.62
April	4.08	5.57
May	2.68	4.18
June	4.51	3.39
July	4.13	4.43
August	10.82	5.17
September	3.43	2.73
October	3.00	2.00
November	2.97	2.53
December	1.46	1.80
TOTAL	45.79	36.66

REVIEW OF WHEAT VARIETIES

The main varieties grown during the year and their acreage percentage for the three-year period 1954–1956 are appended.

ACREAGE PERCENTAGES, 1954–1956

VARIETY	1954	1955	1956
Sabanero	13.3	17.9	21.7
Equator/Baby Equator	6.6	3.9	11.5
131	10.0	12.8	11.0
337	6.7	4.8	} 9.2
341	7.6	11.2	
360	7.0	4.4	
D.C. x Ceres	6.2	5.2	8.1
1066	9.8	9.4	7.6
354	—	0.9	6.5
294/K.S	12.7	7.7	6.2
Regent	0.5	1.4	4.9
184	5.0	6.5	1.9
362	—	—	1.3
356	—	0.5	1.0
358	—	—	0.8
Reward	0.2	0.4	0.8
Others	14.4	13.0	7.5
TOTAL	100.0	100.0	100.0

The main differences in the pattern of distribution lie in the rise in popularity of Sabanero and Equator, and the fall in the 294, 337, 341, 360 group of varieties due to stem rust attack. Varieties 131 and 1066 show little change. In the premium class there has been a marked drop in 184 and an appreciable rise in D.C. x Ceres and Regent: 216.R has disappeared from cultivation due to rust susceptibility. The premium wheats accounted for 15.9 of the acreage total compared with 13.7 per cent in 1955.

RUST AND OTHER DISEASES

A severe outbreak of stem rust (*Puccinia graminis tritici*) developed in the lower wheat areas. The attack was particularly heavy in the Trans Nzoia and at Solai; in both cases severe damage was suffered and many crops virtually destroyed. A feature of the attack was its suddenness, and most of the damage was done within two weeks of the first appearance of the infection. Most varieties were attacked including particularly Regent which, up to this time, had shown field resistance. The greatest collapse, however, was suffered by the variety 354, hundreds of acres of which were so badly damaged as to be not worth reaping. This variety remained virtually free from stem rust in 1955 and yielded extremely well in some areas, particularly in the Trans Nzoia where crops of ten bags an acre were not uncommon. It forms a good example of a useful and high-yielding wheat completely destroyed in the first year of its release. Yet, owing to the vagaries of rust attack, some farmers took off good crops of this very same variety in the middle of severely infected areas. The cause of this is quite unknown. It is of interest that the variety Sabanero, in spite of a rust attack heavier than usual, still gave reasonable yields when neighbouring varieties were very severely damaged.

In the higher areas there was less stem rust, crops in general looked promising and yields should be up to average.

Regarding other diseases there was more yellow ear rust (*Puccinia glumarum*) than usual, and it attacked at a lower altitude than customary. This was probably due to the cold weather in July and August since it is known that cold conditions encourage yellow rust. Glume blotch (*Septoria nodorum*) and Take all (*Ophiobolus graminis*), which were severe in 1955, were generally less in evidence this season.

No comprehensive rust survey has been possible this year due to the absence of a pathologist from the plant breeding team, so it is not possible to say which were the prevalent races. It is likely, however, that since the varieties 354, Regent and 321 rusted for the first time, new rust races have arisen. The reason for this rust build-up is not known but it may well be connected with the abnormally extended rains last year and the lack of any dry season to kill off volunteer wheat plants and the rust spores. The increased scale of short season cropping in both Kenya and Tanganyika may be assisting the build-up. This is, however, pure speculation.

BARLEY AND OATS

The acreage under barley increased considerably in 1956, due to the high incidence of rust in wheat in recent seasons and to the higher barley yields now being obtained.

The range of Scandinavian type barleys has been extraordinarily successful in Kenya, although not yet popular with the breweries. The British variety Proctor has better prospects in this respect and considerable acreages are now being sown to this variety. The variety Research still remains popular for malting but the old variety Prior has almost disappeared.

Breeding to improve the drought resistance of the Scandinavian type of barley is being carried on but the existing varieties are successful in their own right and this is not considered a major project.

Oats in Kenya continue to be limited by rust. Both stem rust (*P. graminis avenae*) and crown rust (*P. coronata*) are serious diseases and there is little doubt they exist in the country in a number of races. Until it is possible to carry out a real study of this question no breeding of oats can be attempted. Oats play a valuable part in the rotation in the higher country as well as providing useful fodder and grain, and there is no doubt that they would be more widely grown if varieties more resistant to rust could be obtained. For the present work on oats remains limited to the testing of imported varieties.

II—Breeding: Wheat, Barley and Oats

The main work is centred at Njoro and Molo, with further testing and multiplication carried out at Kitale, Eldoret, Rongai, Ol Joro Orok, Kinangop and Egerton Agricultural College.

In view of the expanded programme and large amount of material now being carried, no detailed account of the work can be given and only a broad outline will be possible.

CAGE MATERIAL AND NEW ACCESSIONS

At Njoro 70 new wheat crosses were made utilizing varieties extracted from the earlier nurseries which showed resistance to the latest stem rust races. In addition, 247 accessions of all three cereals were grown. The total number of crosses under selection was 151 for wheat and seven for barley.

At Molo selections from 22 wheat crosses were under study. The standard yellow rust differentials were sown for the first time in an endeavour to identify the races present. However, many remained vegetative and failed to set seed.

A small number of new oats were under observation at Molo.

CO-OPERATIVE RUST NURSERIES

This is the third year of our participation in these nurseries. The International Wheat Rust Nursery received from America contained 398 entries and the Near East Co-operative Wheat Rust Nursery from F.A.O., Rome, 383 entries. In addition, the F.A.O. Barley Nursery, containing 64 entries, was also grown. Reports on the performance of the varieties under test were sent to the appropriate authorities and the most promising varieties from these nurseries were harvested for further use.

CEREAL TRIALS

In the various wheat yield trials the main points of interest were as follows. At Njoro the best varieties were the accessions La Prevision, Rio Negro and H.305. The local crosses 358 and 367 yielded exceptionally poorly, a reflection of the very wet year. Unfortunately, all three of these accessions are very susceptible to stem rust and their future is therefore doubtful. At Eldoret the highest yields were given by 358.AA.5.B, La Prevision, 367.AR.3.B.1.A and H462.A.3.4.2.3. The first is now in current use on some scale but has shown a certain degree of susceptibility to stem rust. The H462 is an importation from Wisconsin and has proved a specially quick wheat; it derives from a Fontana-Thatcher-W38-Hope cross and has remained virtually free of stem rust.

In the barley trials the best at Njoro was No. 5 from Eire, followed closely by Rigel, Proctor, Kenia, Binder and Heimdal. At Eldoret the highest yield was also given by No. 5, with Bonus, Kenia, Proctor and Research all very close.

These results confirm that No. 5 is now the highest-yielding variety available for the medium to high altitudes, and it is much to be hoped that it will prove suitable for malting. At Kitale the varieties Kenia, No. 5 and Binder gave the best yields but in all cases the grain was disappointingly thin. This thinness of grain has been a regular feature of the barley trials at Kitale and it seems clear that the existing range of varieties is not really suited to the sandy soils of the Trans Nzoia.

The oat trial at Eldoret gave good yields. The best varieties were Southland, C.I.5430, R.L.1734, R.L.1674 and Zephyr, all of them out-yielding the earlier releases Lampton, Boone and Vikota. At Kitale the oat trial was devastated by heavy attacks of crown and stem rust, no variety giving a good yield. However Fultex in an observation plot was virtually free of both rusts and looks like being a valuable variety; it will be put into trials in the coming season. The various trials at Ol Joro Orok and the Kinangop were inconclusive.

In addition to these trials a large range of observation plots was also sown as a preliminary to the elevation of selected varieties to field trials next season.

CEREALS UNDER MULTIPLICATION

The multiplication of new cereal varieties has been reorganized and there are now three stages: (1) foundation crops on the Plant Breeding Station, (2) mother crops on other Departmental Stations, and (3) pedigree crops with selected farmers. The aim of the scheme is to provide farmers with quality seed as rapidly as possible.

During the season 11 foundation crops of wheat and two of barley were grown at Njoro and 12 wheats at Molo. The former were all introductions of promise, the most interesting being H462.A.3.4.2.3 and Rio Negro from the U.S.A., and Spica from Australia. Although they grew poorly at Njoro during this past season, a number of other varieties are being sent elsewhere for further multiplication where a shorter season prevails. The South African variety 78.M and the Algerian type Florence Aurore 8193 are both to be multiplied in the Naro Moru district: Lawrence from Queensland, and Rushmore and CI 12632 from the U.S.A. are to be grown in the short rains in the Northern Province of Tanganyika. Both these districts grow two crops a year and have need of these quicker varieties.

In addition to these crops, four varieties were resown in November to produce out-of-season crops under irrigation. The most important of these was a selection out of R.L.2150 from Canada; this derives from the cross Marquis² x *Agropyron elongatum*. This variety has so far shown complete resistance to stem rust and confirms the view now current with wheat breeders in America and Canada that a superior form of stem rust resistance is likely to be obtainable from this particular grass species.

At Molo, all the wheats under multiplication were derivatives from the crosses 384 and 385 (Equator x 318), which had shown good resistance to yellow ear rust at the higher altitudes. Two of them, 384.C.7.A.2 and 384.BU.22.M.1, were particularly promising in the field and the former also gave outstanding grain.

Mother crops included 11 wheats and two barleys. Those now due for further multiplication as pedigree crops are new stocks of the two varieties 131 and Sabanero, La Prevision, 362.B.1.A.2 and selections from the cross 367 (Warigo x 184.P.2.1.F). The varieties 359.AA.8.B.1.A, Premier x Bobin² Gaza, and 362.A.1.D.1. were discarded due to stem rust susceptibility. The mother crops of barley were Binder and Velvon. No new oats were included in the scheme this season.

There were four pedigree crops, the wheats H.305-10 and 358.P.7.C and the barleys Heimdal and No. 5. The first-named was unexpectedly attacked by stem rust and was discarded: the remainder are mentioned in the next section. In addition there were a number of other varieties being multiplied under interim arrangements, which could not qualify as pedigree crops. These included the wheats 358.AC.4.A, 358.R.7.E, 362.B.1.A.1.B, 362.B.1.D.3.D, 363.K.1.B.3, Mida Cadet and the durum Capella. The oat 3003.F was also similarly multiplied. These 358 and 362 selections are additional to the varieties 358.AA.5.B and 362.B.1.E.4 which were released last year.

RELEASE OF NEW CEREAL VARIETIES

Twelve new wheats, two barleys and one oat have been released for 1957 plantings. Eight of the wheats were locally bred and four were direct importations which had shown promise on a field scale. Both the barleys and the oat were also direct importations.

A full description of these cereals was published in the *East African Agricultural Journal*, the *Kenya Information Office Fortnightly* and in the local Press, and will not be repeated here. However, a summary of the releases is appended for general information.

VARIETY	Parentage	Altitude Range	Notes
WHEAT—		ft.	
358.AC.4.A	184.P.2.A.1.E	6,500–8,000	Further to 358.AA.5.B released in 1956.
358.P.7.C	x	„ „	
358.R.7.E	294.B.2.A.3	„ „	
363.K.1.B.3	261.S.10.C.2.D	7,000–8,000	
362.B.1.A.1.B	x Warigo	8,000–9,000	Further to 362.B.1.E.4 released in 1956.
362.B.1.D.3.D	Equator x	„ „	
1066/1..	294.M.7.C.6.C	„ „	
1066/6	Unknown	„ „	
Mida x Cadet	„	6,000–7,000	Direct importation from Canada.
Capella ..	—	7,000–8,000	Direct importation (T. durum) from Italy.
Hopeful ..	—	7,000–8,000	Direct importation from S. Africa.
Impala ..	—	„ „	„
BARLEY—			
No. 5 ..	Kenia x Spratt Archer	6,500–9,000	Direct importation from Eire.
Heimdal ..	Peragis x Maja	7,000–9,000	Direct importation from Sweden.
OATS—			
3003.F ..	—	8,000–9,000	Direct importation from Canada.

III—Breeding—Maize

Maize breeding work continued at Njoro and Kitale, and in the special breeding programme for resistance to *Puccinia polysora* at Kwale in the Coast Province.

GENERAL BREEDING PROGRAMME

As outlined in last year's report, the main breeding work has now moved from Njoro to Kitale with the appointment of a breeder to take over and expand

the work at this latter centre. At Njoro the final stage of purifying the old inbred lines was completed and these, together with more recent inbred material, will now be top-crossed in the coming season to select the lines with the best combining ability for the possible production of synthetics. The trial of 86 S_1 lines, out of Njoro maize, top-crossed to the first synthetic, was highly significant. Yields ranged from 25 to 12 bags per acre and the mean of 19 bags also corresponded to the level of yield of the ordinary station maize; the synthetic itself gave $20\frac{1}{2}$ bags. The top three inbreds significantly out-yielded both the mean and the station maize and the top two also exceeded the synthetic significantly. A retrial will probably be carried out, but in the meantime work can proceed on preparing for the formation of synthetic II.

At Kitale expansion and development of the maize programme continued. A considerable amount of old material has now been reselected, and some 150 medium-generation and 100 new inbreds were top-crossed during the past season for evaluation in trial in 1957. An additional 400 selfings were made to initiate new lines for future work.

Primarily such material will be used in the production of synthetics, but there will be the possibility of proceeding to hybrids later. The first Kitale synthetic was compounded in 1954 as an interim measure, use having to be made of top-cross seed, not inbred seed. The synthetic was under multiplication in 1956 but proved disappointing; in the yield trial at Kitale it yielded 26.9 bags per acre but the station maize exceeded this by 1.5 bags. Further multiplication is being withheld till more trials have been carried out.

A preliminary trial was carried out at Kitale to assess the degree of association of certain cob characters with yield. Results have yet to be fully analysed, but the main trends observed were that selection for heavy or very long cobs gave the best yield and that lowest yields followed the sowing of seed from cobs not fully covered at the tip by the husk.

Thought is now being given to widening the basis of the work to increase the prospect of achieving higher yields. Accordingly a collection of the best stocks of local farm maize was put into a polycross plot to provide the basis of a new source of breeding material. Looking further afield, a collection of some 120 maizes of Caribbean origin was grown, but all proved extremely susceptible to *Puccinia sorghi* and no material of value was obtained.

CO-OPERATIVE TRIALS

Although these trials were not grown this past season at Njoro or Kitale, we still remained responsible for their organization at certain other centres in the country. The general result of the two years' trials was that certain varieties have shown promise for breeding purposes at sites at which they had not previously been grown. It has been decided by the Specialist Committee that these trials have served their immediate purpose and there will now be a pause whilst the results are examined in detail.

POLYSORA WORK

Homozygous resistant lines from original Kilifi and E.A.A.F.R.O. crosses, identified by check tests at Muguga, were put into a polycross plot to form the basis of a first bulk issue. Vigour was surprisingly good but there were eight susceptible plants in 440 which escaped detection in the tests. Nevertheless this is most satisfactory and is well within the limits of experimental error in such small-scale tests. This polycross material will now be sufficient for a two-acre bulking plot in the coming season. Lines detected as still heterozygous were again selfed to extract further pure breeding material for a second issue.

Back-crossing of similar original crosses to local white maize reached the third back-cross and selfing will now be undertaken to obtain resistant lines to form a stock with more vigour and local adaptability than can be expected from the earlier stock. In making this we are now concentrating on AFRO 24 derivatives as containing the gene 2 which confers resistance to both races of *P. polysora* so far found in East Africa. AFRO 29 and 30 material is being held in abeyance in case there should be a change in the rust race position. This work all aims at the production of white-grained maize but the yellow segregates are being stored in case this type should be useful at a later date.

MAIZE RELEASE

The first synthetic from Njoro was grown on a wide scale throughout Kenya during the year and was released at the end of the season. As expected, this maize did well in areas close to Njoro, but further distant, particularly in the Trans Nzoia, it proved disappointing. In trial at Njoro the synthetic out-yielded the station mass-selected maize and showed itself to be appreciably earlier and more uniform. Although the grain individually was smaller than station maize, this was more than compensated by a greater number of cobs, indicating that "passengers" had been reduced in number. A second synthetic, complementary to the first, is now being compounded as described above.

IV—Wheat Quality Investigation

These investigations, run in co-operation with E.A.A.F.R.O. and Unga Ltd., were in their second year. Certain changes in the programme were made in the light of the 1955 results, but in general the work follows the same main lines. The original programme was described in some detail in last year's report. The incidence of stem rust and unusually wet seasons has largely spoiled the results so far obtained.

V—Publications

1. H. C. Thorpe and G. E. Dixon, "Release of New Cereal Varieties—1956". *East African Agricultural Journal*, April, 1956. (Also in *K.I.O. Fortnightly* and local Press).
2. H. C. Thorpe, "Cereals in Kenya—1956/57". *K.I.O. Fortnightly* and local Press.
3. H. C. Thorpe, "New Cereals for Multiplication", *K.I.O. Fortnightly*, and local Press.
4. "Synthetic Maize—A new breeding policy for Kenya", *K.I.O. Fortnightly*.
5. "Cereal Seed Certification". *K.I.O. Fortnightly*.
6. Papers entitled "Report on breeding rust-resistant maize in Kenya" by H. C. Thorpe and H. H. Storey, and "Co-operative Maize Trials, 1956—Summary and interim Report" by G. E. Dixon were submitted to the Specialist Committee on Agricultural Botany.

VI—Acknowledgments

Acknowledgment is made once again to members of the staffs of the East African Agriculture and Forestry Research Organization and Messrs. Unga Ltd. for considerable help with various tests, crop statistics and subjects of mutual interest.

It is again a pleasure to record the help received from overseas and, in particular, the receipt of breeding material of considerable value.

H. C. THORPE,
Senior Plant Breeder

ANNUAL REPORT OF THE COFFEE RESEARCH STATION, RUIRU, 1956

Introduction

The weather and conditions affecting the trees and crop, in the East of Rift districts particularly, were similar in many respects to those in 1955. Exceptional rains in January and February allowed a rapid recovery from the effects of crop strain and the defoliation due to Leaf Rust, but engendered another Rust epidemic of even greater severity. Fortunately, widespread early flowerings brought crops to maturity earlier than normal and generally most of the strain on the trees had occurred before heavy leaf-fall started. Nevertheless, heavy Leaf Rust infection and widespread attacks of Leafminers were responsible for serious defoliation during the second half of the year. The prolonged dry weather which followed poor rainfall in May lowered the quality of the crop, especially the latter half of the harvest. From September to the end of the year rainfall was light but well distributed.

RAINFALL AT THE DEPARTMENT'S COFFEE STATION DURING 1956 (INCHES)

1956	Ruiru	Nairobi	Makuyu	Kitale
January	3.90	5.16	6.14	3.42
February	3.50	2.56	1.81	3.21
March	4.83	3.04	4.91	2.94
April	8.98	6.32	11.98	4.84
May	3.20	2.53	2.94	5.93
June	0.88	0.64	0.04	1.97
July	0.54	0.73	0.14	5.17
August	1.01	0.42	0.18	8.51
September	1.33	0.66	1.00	4.17
October	2.62	1.21	1.44	4.29
November	5.57	3.87	8.32	0.62
December	0.61	0.92	1.75	5.57
TOTAL INCHES ..	36.97	28.46	39.81	50.64
TOTAL DAYS ..	128	100	90	169

Among the number of staff changes during the year there were in particular the transfer on promotion to Chief Research Officer of Mr. A. R. Melville, who was succeeded by Mr. P. A. Jones as Officer-in-Charge in February. Mr. J. A. N. Wallis assumed duty as Agricultural Officer (Investigations) in May.

A special Coffee Berry Disease Research Unit was formed at the end of 1955 to undertake investigation of all relevant aspects of the disease in the Colony. The unit is under the direction of Dr. F. J. Nutman whose report on the year's work is published later in this section.

In the field of processing research investigations into the problems of artificial drying of parchment coffee were continued as a special project by the East African Industrial Research Organisation and were conducted by Mr. J. F. McCloy, Senior Scientific Officer, who was appointed to succeed Mr. Llewelyn in April. In June Mr. J. S. Grant, Assistant Agricultural Officer, was seconded to assist with drying studies on estates. Although a final conclusion is not yet in sight, useful progress was made during the year. Studies were designed to assess the effect on coffee quality of a range of drying temperatures applied at various

stages in the drying cycle and the relation of sun-drying to the production of good quality coffee. Full reports of these studies were issued periodically by the East African Industrial Research Organization.

In agronomic research one of the main developments was the inception of a long-term irrigation trial designed to study the important questions arising from the rapidly increasing practice of irrigation in the drier coffee-growing areas. The design of the trial, described in the report of the Agricultural Officer (Investigations), was decided after much deliberation and in collaboration with Dr. H. C. Pereira, E.A.A.F.R.O. Papers describing fully the approach to the problem and the layout of the trial were published as follows:—

The Seasonal Assessment of Water Needs in the Irrigation of Coffee, by H. C. Pereira. *East African Agricultural Journal*, XXII, 4, 188.

Irrigation Experiments at the Coffee Research Station, Ruiru, by P. A. Jones and J. A. N. Wallis. *East African Agricultural Journal*, XXII, 4, 186.

Field investigations of the effects of grass mulches, nitrogenous fertilizers and cattle manure have continued, and although the conclusions previously obtained have been largely endorsed some interesting new indications of the interaction of these soil treatments are emerging.

Messrs. Rayner and Wallis have continued research on anti-leaf-fall spraying in trials at Ruiru, Kitale and Makuyu. The relative value of high-, medium- and low-volume sprays is now under scrutiny in machine spray trials at Ruiru. At other sites time studies have shown that "tonic" applications in May control leaf-fall more effectively than at other times and lead to greater crop increments. Various other and less important aspects of anti-leaf-fall spraying were examined in the course of the year.

Conditions predisposing to another Leaf Rust epidemic underlined the importance of new lines of research in field and laboratory, wherein efforts to elucidate the factors affecting infection and their relation to control by fungicide spraying have yielded results of profound significance, necessitating a revised approach to spraying technique. Varietal resistance is assuming a new importance as development of coffee growing in African areas is accelerated. Consequently the work of routine testing of Rust collections was started to determine differential host reaction and the distribution of physiologic races of the Rust throughout the Colony.

Rust resistant varieties from other territories must necessarily be subjected to local field tests before their value can be established. For the purpose a series of Rust Exposure trials was laid down in the several climatic zones of the Colony to reveal the differential reaction of imported and local strains and to confirm the results of laboratory studies wherein the distribution of Rust races is determined.

The Agricultural Chemist's main line of research continued to be soil nitrogen and nitrogen nutrition of coffee. From this vast and complex study some useful results were obtained, especially those arising from laboratory incubation studies. Mr. Robinson's preliminary examination of magnesium nutrition of coffee showed that this subject deserves to be a major research project. The investigations described in his report show how the magnesium deficiency condition is defined and although a practical remedy is no problem, the full effects of magnesium deficiency have not yet been determined.

The most important developments in entomology have been the work of testing the value of some new insecticides in the control of Antestia and Leaf-miners. Serious outbreaks of the latter pest caused much concern to growers, but fortunately experiments indicated that a fully effective control was in sight. Mr. McCrae devoted much attention to studying Tip Borers; although a clearer understanding of the biology of both species was attained, unfortunately in respect of *Eucosma nereidopa*, the more noxious species, no suitable control could be found.

In African districts coffee growing developed at a rapid pace during the year. In addition to surveys in zones of prospective development the Coffee Team continued to serve as technical advisers to departmental field officers in African areas. The post of liaison officer between the research station and the African coffee areas was filled by the appointment of Mr. B. F. Hanger, Agricultural Officer, in August; after a period of study at the research station Mr. Hanger began his liaison duties towards the end of the year.

P. A. JONES,
Officer-in-Charge (Coffee Research Station).

ANNUAL REPORT OF THE ENTOMOLOGIST (COFFEE SERVICES), 1956

The General Pest Situation

The year was notable for the activity of Lepidopterous pests. Outbreaks of Leafminer (*Leucoptera* spp.) and Leaf Skeletoniser (*Epiplima dohertyi* Warr.) occurred. Tip Borer, *Eucosma nereidopa* Meyr, did serious damage to growth required for new multiple-stem cycles in Upper Kiambu where it also attacked the berries. Another Tip Borer, *Archips occidentalis* Wals., did similar damage to young growth in Thika, but recovery was satisfactory owing to the more rapid growth of the coffee in this area.

Antestia, *Antestiopsis lineaticollis* Stal, caused trouble on estates which had neglected routine testing and control measures. In a serious outbreak in Ruiru an average population of 250–300 *Antestia* per tree was found.

Research on Insect Pests of Coffee

1. ANTESTIA, *Antestiopsis lineaticollis* Stal.

(a) *Airspraying*.—In an experiment to assess the effectiveness of aircraft spraying, the following treatments were used:—

(1) 3 Pints D.D.T. 25 per cent emulsion concentrate per acre.

(2) 2 Pints D.D.T. 25 per cent emulsion concentrate + 3 fl. oz. of an emulsifiable concentrate of pyrethrum containing five per cent pyrethrins and 50 per cent piperonyl butoxide, per acre.

Treatment 1 reduced the *Antestia* population from 67.3 per tree to 19.4 per tree. Treatment 2 gave a reduction from an average of 21.6 *antestia* per tree to 4.6 per tree. As neither treatment gave the necessary reduction to an average of under 2 per tree, results were not considered satisfactory. No other opportunity occurred during the year to pursue this work.

(b) *Sprays against Antestia*.—A number of insecticides were tested in a series of experiments against *Antestia* towards the end of the year. Of these, Chlorthion and Malathion showed promise. As Malathion was locally available work was pressed forward with this insecticide, but recommendations on its use could not be made before the end of the year.

2. LEAFMINERS, *Leucoptera coffeella* Guer. and *L. coffeina* Washb.

Serious outbreaks of both species of Leafminer occurred in the Central Province in the latter half of the year.

A number of insecticides were tested against leafminer larvae in the leaves and of these, Diazinon was the most efficient. This insecticide regularly gave kills of 90–100 per cent of the larvae within the leaves. As an interim recommendation, the use of Diazinon 60 per cent emulsifiable concentrate applied to the foliage at a concentration of half pint of the concentrate in 40 gallons of water was advised. A single application did not always give complete control, but further work on spray timing could not be done before the outbreaks ceased.

Most attacks of Leafminer were due to natural parasite failures and did not invariably follow foliage sprays of persistent insecticides, although this was thought to have happened on some estates.

3. LEAF SKELETONISERS, *Epiplima dohertyi* Warr. and *Odites artigena* Meyr.

The former insect caused damage from June until the end of the year, on some estates in Ruiru. Control of the larvae was achieved by dusting with a five

per cent D.D.T. dust at a rate of 30 lb. per acre, or by dusting with a synergised pyrethrum dust containing 0.2 per cent pyrethrins and 2 per cent piperonyl butoxide at a rate of 10-12 lb. per acre. The latter insect was noticed on an estate in Thika, but the attack was not serious and no control measures were required.

4. TIP BORERS, *Eucosma nereidopa* Meyr. and *Archips occidentalis* Wals.

(a) *Eucosma nereidopa* Meyr. This insect did most damage in Upper Kiambu and the Taita Hills, but was also found on coffee in areas west of the Rift Valley.

No satisfactory control of this insect was achieved but information on parasites attacking its larvae and on its biology was obtained.

(b) *Archips occidentalis* Wals. Control of the larvae of this moth was achieved by sprays of 0.1 per cent D.D.T. on the tips and apical foliage of young vertical growth. The larvae do not confine their activities exclusively to boring in the tips, and feed to some extent on the foliage. Control was therefore not so difficult as with *E. nereidopa*, whose larvae do not leave their tunnels until they have ceased to feed.

5. FRUIT FLY, *Ceratitis capitata* Wied.

This insect caused a certain amount of fall of green berries in the early part of the year. The berry fall was caused by the flies ovipositing but the larvae failed to mature in this material. The damage was fleeting but alarming at the time. No control measures could be taken before the damage was noticed.

6. WHITE BORER, *Anthores leuconotus* Pasc.

A campaign against White Borer was carried out in the Makuyu, Mitubiri and Donyo Sabuk areas during the first three months of the year. Growers were given the option of controlling the pest by either fumigation or spraybanding the trees with half per cent dieldrin.

Field experimentation to determine the efficiency of dieldrin spraybanding was continued. The results were much better than those obtained by fumigation of the larvae, and growers were accordingly advised to use dieldrin to the exclusion of other methods.

7. COFFEE LACEBUG, *Habrochila ghesquierei* Schout.

Lacebug was found for the first time in the Central Province on coffee in Kabete. The damage done was usually of a minor nature, but sprays of Diazinon 60 per cent emulsion concentrate gave good control of it at a concentration of half a pint of Diazinon in 40 gallons of water. Two sprays, separated by a period of three weeks were necessary as the eggs of the insect were not killed by the insecticide. The Mirid predator, *Stethoconus* sp. was found in association with the Lacebug in Kabete.

Miscellaneous Items

The compilation of a list of the insects associated with coffee in Kenya occupied some time. This list was for incorporation into a comprehensive list of all recorded insect pests of agriculture in the East African Territories.

The collection of insects associated with coffee also received attention and is now fairly comprehensive. The assistance rendered by the Commonwealth Institute of Entomology in the identification of many insects is gratefully acknowledged.

The Senior Entomologist, Dr. R. H. Le Pelley assumed technical supervision of coffee entomology from July.

D. J. McCRAE,
Entomologist (Coffee Services).

REPORT OF THE AGRICULTURAL OFFICER (INVESTIGATIONS), COFFEE SERVICES FOR THE YEAR 1956

Cultivation Trial

Table I shows that in 1956 the clean weeded plots yielded over three times as much clean coffee as was harvested from plots which had only been weeded at the end of each rains. Although there was no overall significant difference between implements, on the slashed plots the highest yields were recorded from those plots cultivated with a disc-harrow. This is unlikely to be an important result since just the opposite effect reached statistical significance in 1955. In 1956 cattle manure caused a highly significant reduction in the yield of clean coffee, but the mean annual figures for the nine years 1948-1956 show there has been a yield increase of six per cent attributed to the annual application of about $3\frac{1}{2}$ tons of "boma" manure per acre.

TABLE I—YIELD SUMMARY, 1947-1956
Mean annual yields in cwt. of clean coffee per acre

TREATMENT	1956 Yield	1947-1956 Yield % of W_0	
WEEDING—			
W_0 Clean weeding	10.21	8.69	100
W_1 Weeds slashed	8.31	6.73	77
W_2 Tall weeds	3.13	5.10	59
IMPLEMENT—			
T_0 Forked hand-hoe	7.01	6.93	% of T_0 100
T_1 Disc-harrow	7.60	6.72	97
T_2 Mould board plough	7.04	6.86	99
LEAST SIGNIFICANT DIFFERENCE—			
$p=0.05$	1.48		
$p=0.01$	2.04		
ATHI PLAINS "BOMA" MANURE—			
Annual dressing		1948-1956 % of —C	
+C 1 x 4 gall. tin/tree (approx. $3\frac{1}{2}$ tons/ acre)	6.44	7.13	106
—C Nil	7.99	6.74	100
LEAST SIGNIFICANT DIFFERENCE—			
$p=0.05$	1.01		
$p=0.01$	1.38		

Rotovator Trial

Although this trial was commenced at the end of 1953, the only reasonable crop was picked in 1955 because the block of single-stem coffee on which this trial is situated has been in a marked condition of biennial bearing, and negligible crops were harvested in 1954 and 1956. It is hoped that the severe pruning after the 1956 crop will limit the range of this yield fluctuation.

TABLE II—YIELD SUMMARY, 1954-1956
Mean annual yields in cwt. clean coffee per acre

TREATMENT	1954-1956
IMPLEMENT—	
R—Rotary hoe	5.97
F—Forked hand-hoe	5.81
WEEDING—	
W ₀ —Clean weeding	6.21
W ₂ —Tall weeds	5.57
MULCHING—	
+M—Alternate inter-row mulched ..	6.85
—M—No mulch	4.93
LEAST SIGNIFICANT DIFFERENCE—	
p=0.05	0.51
p=0.01	0.74

Table II shows that in the mean annual yields of the three crops recorded so far there is no significant difference between implements, but both mulching and clean weeding have led to considerable increases in the yield of clean coffee.

Manurial Trial I

In 1956 plots which had received 1 or 2 cwt. of sulphate of ammonia per acre yielded significantly more clean coffee than the control plots.

TABLE III—YIELD SUMMARY, 1947-1956
Mean annual yields in cwt. clean coffee per acre

RATE OF APPLICATION PER ANNUM	1947-1951	1956	1952-1956
NITROGEN—			
N ₀ —Nil	4.44	3.91	7.38
N ₁ —1 cwt./acre 23 lb. N. Sulphate of ammonia ..	4.47	5.32	7.83
N ₂ —2 cwt./acre 46 lb. N. Sulphate of ammonia ..	4.75	4.85	8.34
CATTLE MANURE—			
C ₀ —Nil	4.66	5.08	7.75
C ₁ —1 x 4 gall. tin/tree (3½ tons/acre)	4.52	4.06	7.71
C ₂ —2 x 4 gall. tin/tree (7 tons/acre)	4.48	4.93	8.09
LEAST SIGNIFICANT DIFFERENCE—			
p=0.05	0.25	1.42	0.27
p=0.01	0.33	1.96	0.38

Table III shows that since conversion to a multiple-stem system of pruning in 1952, the mean annual yield response to 1 cwt. of sulphate of ammonia has been highly significant and a similar difference has been recorded between the two rates of fertilizer application during this period.

There was no significant response to dressings of cattle manure in 1956 and in individual years significant yield differences have only been recorded in 1951 and 1953 when the application of about 7 tons of cattle manure per acre per year reduced the yields of clean coffee by 0.98 cwt./acre and 1.17 cwt./acre in the respective years. From the overall figures for the period 1952-1956, however, it may be seen that a yearly dressing of some 7 tons of cattle manure per acre has led to a statistically significant ($p=0.05$) mean annual increase of 0.34 cwt. of clean coffee per acre.

A negative interaction of manure or nitrogen has been reported from this and other trials but its precise form remains obscure.

TABLE IV—THE INTERACTION OF A NITROGENOUS FERTILIZER WITH CATTLE MANURE
1952-1956 yields expressed as percentages of the control treatment N_0C_0

RATE OF APPLICATION PER ANNUM	CATTLE MANURE		
	C_0 Nil	C_1 1 x 4 gal. tin/tree	C_2 2 x 4 gal. tin/tree
NITROGEN—			
N_0 —Nil	100	107	118
N_1 —23 lb. N	115	117	113
N_2 —46 lb. N	127	116	126

Table IV summarizes this aspect of the trial for the period 1952-1956 and shows that in the presence of cattle manure the difference between N_2 and N_0 is less than the difference between these two treatments in the absence of cattle manure. This discrepancy is largely accounted for by the yields recorded from the N_0C_2 plots being greater than those from the N_0C_0 plots. In the period since 1952 it appears that the application of about 7 tons of cattle manure per acre each year has produced a highly significant yield increase on plots not receiving any fertilizer, but has had no measurable effect on the yields from plots to which have been applied yearly dressings of sulphate of ammonia.

Manurial Trial II

The 1956 yields from this trial have been omitted from this report because their variability was so high that they could add no useful information to the results already published in earlier reports.

This trial is situated in an area of single-stem coffee which is in a condition of most marked biennial bearing. It is hoped that the severe pruning policy adopted after the 1956 crop will overcome this unsatisfactory state of affairs.

Manurial Trial III

There was no significant difference between treatments in the yields of the 1956 crop. Table V shows that in the four years 1953-1956 the mean annual response to the yearly application of 46 lb. of nitrogen per acre was 0.99 cwt. of clean coffee per acre, and when double the quantity of nitrogen was applied the yield was raised by a further 0.25 cwt. of clean coffee per acre. There has been no detectable yield differences between the time of fertilizer application treatments.

TABLE V—YIELD SUMMARY, 1953–1956
Mean annual yields as cwt. of clean coffee per acre

TIME OF APPLICATION	RATE OF SULPHATE OF AMMONIA		
	Nil	2 cwt./acre 46 lb. N./acre	4 cwt./acre 92 lb. N./acre
All in long rains (April)		8.88	9.28
All in short rains (November) ..		9.03	9.47
Half in each rains		9.22	9.02
Mean annual yield.. ..	8.04 100%	9.03 112%	9.28 115%

Manurial Trial IV

(formerly reported as "Nitrogen Trial")

In the third crop from this trial, which was recorded in 1956, the mulch treatments influenced the yields of clean coffee significantly for the first time. All the mulch treatments increased the crop by over 100 per cent of the control yield, but there was no significant difference between mulch treatments.

TABLE VI
1956 yields in cwt. of clean coffee per acre

NITROGENOUS FERTILIZER PER ACRE/YEAR	MULCH TREATMENTS				Means
	Nil	Alternate inter-rows	All rows	All inter- rows	
Nil	8.88 (a)	17.71 (a)	17.46 (a)	17.29 (a)	15.34 (d)
69 lb. N. 3 cwt. sulphate of ammonia ..	7.69 (a)	16.85 (b)	16.83 (b)	17.42 (b)	14.70 (g)
138 lb. N. 6 cwt. sulphate of ammonia ..	8.52 (a)	15.61 (b)	16.62 (b)	16.60 (b)	14.34 (g)
Means	8.36 (c)	16.72 (e)	16.97 (e)	17.10 (e)	14.79

LEAST SIGNIFICANT DIFFERENCE

Between	p=0.05	p=0.01
(a) and (a) ..	3.05	4.09
(b) and (b) ..	2.17	2.91
(a) and (b) ..	2.65	3.56
(c) and (e) ..	1.58	2.12
(e) and (e) ..	0.68	0.92
(d) and (g) ..	1.36	1.82
(g) and (g) ..	0.58	0.78

The high levels of nitrogenous fertilizer used in this trial produced no detectable yield differences between treatments in 1956 or in the mean yield figures for the three years 1954–1956.

TABLE VII—YIELD SUMMARY, 1954-1956
Mean annual yields in cwt. of clean coffee per acre

NITROGENOUS FERTILIZER/ ACRE/YEAR	MULCH TREATMENTS				Means
	Nil	Alternate inter-rows	All rows	All inter- rows	
Nil	9.04 (a)	12.14 (a)	11.68 (a)	11.22 (a)	11.02 (d)
69 lb. N. 3 cwt. sulphate of ammonia ..	9.17 (a)	12.45 (b)	12.68 (b)	12.71 (b)	11.75 (g)
138 lb. N. 6 cwt. sulphate of ammonia ..	10.21 (a)	11.69 (b)	13.60 (b)	12.40 (b)	11.97 (g)
Means	9.47 (c)	12.09 (e)	12.65 (e)	12.11 (e)	11.58

LEAST SIGNIFICANT DIFFERENCE

Between	p=0.05	p=0.01
(a) and (a) ..	3.18	4.27
(b) and (b) ..	2.26	3.03
(a) and (b) ..	2.77	3.72
(c) and (e) ..	1.65	2.21
(e) and (e) ..	0.71	0.96
(d) and (g) ..	1.42	1.90
(g) and (g) ..	0.60	0.81

TABLE VIII.—THE EFFECT OF FERTILIZER PLACEMENT ON THE COFFEE YIELD RESPONSE TO THE FERTILIZER

Mean Annual Yields in cwt. Clean Coffee per acre

FERTILIZER PLACEMENT	SULPHATE OF AMMONIA		Mean
	69 lb. N.	138 lb. N.	
1956—			
Applied to the bare soil ..	17.46	15.48	16.47
Applied over the mulch ..	16.60	17.07	16.84
Mean	17.03	16.28	16.66

LEAST SIGNIFICANT DIFFERENCE

p=0.05

p=0.01

Within the table

0.88

1.19

Between marginal means

0.63

0.84

FERTILIZER PLACEMENT	SULPHATE OF AMMONIA		Mean
	69 lb. N.	138 lb. N.	
1954–1956—			
Applied to the bare soil ..	13.78	12.49	13.14
Applied over the mulch ..	11.97	12.63	12.30
Mean	12.88	12.56	12.72

LEAST SIGNIFICANT DIFFERENCE

p=0.05

p=0.01

Within the table

0.92

1.24

Between marginal means

0.65

0.87

Table VIII shows the effect on the yield of clean coffee of two positions of nitrogenous fertilizer placement. It appears that in 1956 the sulphate of ammonia was of more value at the higher level when applied over the mulch, but that at the lower level, which produced the greater response, the fertilizer placed on the bare soil was the more effective. This latter observation is supported by the 1954–1956 mean annual yield figures but nevertheless the real implication of these results remains uncertain because the nitrogenous fertilizer has produced no significant increase in yield (*see* Table VII).

Mulch and Soil Regeneration Trial

Striking yield responses to all mulch treatments were recorded from the 1956 crop. To some extent this has come about because the unmulched plots carried moderate crops in 1954 and 1955 whereas the mulched plots carried a very heavy crop in 1954, a rather low one in 1955 and then produced very high yields in 1956.

TABLE IX.—YIELD SUMMARY, 1950–1956
Mean Annual Yields in cwt. of Clean Coffee per acre

ANNUAL TREATMENTS	1956	1950–1956
MULCH—		
(a) All inter-rows mulched pre-rains—March	21.96	9.76
(b) Alternate inter-row mulched pre-rains— March	19.44	9.13
(ab) All inter-rows mulched post-rains—June/ July	21.25	9.56
(1) CONTROL—No mulch	12.17	7.45
LEAST SIGNIFICANT DIFFERENCE—		
p=0.05	1.30	0.53
p=0.01	1.76	0.72
		1951–1956
NITROGENOUS FERTILIZER—		
(d) 46 lb. N./acre as NH_3	18.62	10.38
(e) 46 lb. N./acre as NO_3	19.01	10.76
(de) 46 lb. N./acre $\frac{1}{2}$ NO_3 + $\frac{1}{2}$ NH_3	19.14	10.28
(1) CONTROL—No N.	18.05	9.80
LEAST SIGNIFICANT DIFFERENCE—		
p=0.05	1.30	0.64
p=0.01	1.76	0.86
		1950–1956
CATTLE MANURE—		
+C 2 x 4 gall. tins/tree approx. 7 tons/acre ..	19.14	9.15
—C CONTROL—No cattle manure	18.27	8.81
LEAST SIGNIFICANT DIFFERENCE—		
p=0.05	0.92	0.37
p=0.01	1.24	0.51

The irregularities in yield are marked in the figures in Table IX which show that in the seven years 1950–1956 mulching has increased the mean annual yields by between 2.31 cwt. and 1.68 cwt. of clean coffee per acre. The “all inter-row pre-rains” mulch treatment has produced significantly more clean coffee than the “alternate inter-row” treatment applied at the same time.

No overall significant differences were recorded between the fertilizer or manure treatments in 1956, but in the mean annual yields for 1951–1956 the treatment in which the nitrogen has been applied in the form of nitrate alone is very significantly better than control, though not significantly better than the other fertilizer treatments.

Mulch x Nitrogen Trial—Kitale

A new trial was laid down at the Kitale sub-station to investigate the responses of coffee to various mulch and fertilizer treatments under local conditions.

The treatments which are arranged in a 5 x 5 Latin Square with 20-tree plots are as follows:—

- (1) Control.
- (2) Urea (5 oz./tree) post-flowering—April/May.
- (3) Alternate inter-row Napier grass mulch post-rains—October.
- (4) Alternate inter-row Napier grass mulch post-rains—October—with Urea (5 oz./tree) post-flowering.
- (5) Alternate inter-row maize stover mulch applied in January/February.

Pruning Trial

Following heavy cropping in 1955 the single-stem trees yielded practically no crop in 1956, whereas the multiple-stem trees continued to crop at a moderate level. This characteristic of the multiple-stem system of pruning is reflected by the more consistent quality of coffee produced. Table X includes information on the mean annual percentage of clean coffee which has been retained by a grade "A" screen during the period 1951–1956.

TABLE X—YIELD SUMMARY, 1946–1956
Mean annual yields in cwt. of clean coffee per acre

YEAR	Multiple Stem 3 heads	SINGLE STEM			LEAST SIGNIFICANT DIFFERENCE	
		Capped once	Capped 3 times	2 stems capped once	p=0.05	p=0.01
1956 ..	8.54	0.05	0.01	0.04		
1946–1956..	6.69	6.96	6.58	7.14	0.19	0.26
<i>Mean Annual Grade "A" Percentage</i>						
1951–1956..	32.1	26.1	23.0	30.0	2.1	2.9

Machine Spray Trial I

The 1956 yields from this trial reflected those of the previous year when the crop from the treated plots was over 300 per cent of that from the control plots. Table XI shows that there was no significant difference between treatments in 1956 and that in the mean yield for the two years the sprayed plots yielded between 15 per cent and 30 per cent more than the unsprayed.

TABLE XI—YIELD SUMMARY, 1955–1956
Mean annual yields in cwt. of clean coffee per acre

LB. OF A 50 PER CENT COPPER FORMULATION/100 GALLONS OF FLUID					Gallons Spray/acre	1956	1955–1956
Nil ..	..	..	..	..	Nil	14.84	8.94
6.8 lb.	..	..	..	..	30 Airblast	11.73	10.87
6.8 lb.	..	..	..	..	60 Airblast	10.31	10.30
13.6 lb.	..	..	..	..	30 Airblast	11.92	11.21
13.6 lb.	..	..	..	..	60 Airblast	14.75	11.58
6.8 lb.	..	..	..	..	120 High Vol.	12.67	11.57
LEAST SIGNIFICANT DIFFERENCE—							
p=0.05						5.74	
p=0.01						7.94	

Machine Spray Trial II

This trial was commenced in May, 1956, to compare a very low-volume sprayer ("Micron") with an "airblast" machine ("Agro Airblast") as implements with which to apply the copper spray used to reduce leaf-fall.

Treatments

(a) 4.08 lb. "Perenox" in 60 gallons of spray per acre using an "Agro Airblast" sprayer.

(b) 0.68 lb. "Perenox" in 10 gallons of spray per acre using a "Micron" sprayer.

(c) 1.36 lb. "Perenox" in 10 gallons of spray per acre using a "Micron" sprayer.

(d) 3.40 lb. "Perenox" in 10 gallons of spray per acre using a "Micron" sprayer.

(e) Control—no spray.

No yield was recorded from this trial in 1956 as it has been found in earlier experiments that the first yield response in such a trial is recorded in the year following the first copper spray.

Makuyu Spray Trial

No significant difference was recorded in the 1956 crop but as Table XII shows in the mean yields for the two years 1955 and 1956 the Long Rains sprays have increased the yields by over 30 per cent and that the late Long Rains spray treatment (May/June) is significantly better than the early Short Rains treatment in early November.

TABLE XII—YIELD SUMMARY, 1955–1956

Mean annual yields in cwt. of clean coffee per acre

6.8 LB. OF A 50 PER CENT COPPER FORMULATION PER 100 GALLONS AT 1 PINT/TREE	1956	1955–1956
T ₀ No spray	6.25	5.41
T ₁ Early Long Rains	7.10	7.02
T ₂ Late Long Rains	6.99	7.41
T ₃ Early Short Rains	6.86	6.15
LEAST SIGNIFICANT DIFFERENCE—		
p=0.05	1.54	1.05
p=0.01	—	1.51

Variety Trials at the Coffee Research Station, Ruiru

The two variety trials which were planted at the Coffee Research Station, Ruiru, in 1950 and 1951 have now yielded four and three crops respectively. The mean annual yields are summarized in Tables XIII and XIV.

TABLE XIII—VARIETY TRIAL I, 1953–1956
Mean annual yields in cwt. of clean coffee per acre

VARIETY	Yield	VARIETY	Yield
SL 30	9.84	KIT 107	8.04
SL 14	9.83	SL 1	8.03
SL 28	9.38	KIT 106	7.99
SL 19	9.04	KIT 37	7.82
KIT 27	8.55	KIT 251	7.81
KIT 85	8.29	KIT 13	7.66
KIT 64	8.27	KIT 145	7.57
SL 17	8.22	KIT 109	7.48

LEAST SIGNIFICANT DIFFERENCE

$p=0.05$ 1.05

$p=0.01$ 1.40

TABLE XIV—VARIETY TRIAL II, 1954–1956
Mean annual yields in cwt. of clean coffee per acre

VARIETY	Yield	VARIETY	Yield
SL 34	71.71	N 100	8.74
N 218	11.67	SL 28	8.64
Dalle Mixed	11.00	M 65	8.55
M 83	9.98	Kenya Selected	8.23
M 6	9.80	Series "L"	8.18
K 7	9.41	SL 18	7.65
SL 9	9.41	Kents	7.60
SL 2	9.35	K.P. 532	7.10
SL 10	9.11	Dilla and Alghe	7.01
Mocha	8.90	M 48	6.71
		SL 6	5.60

LEAST SIGNIFICANT DIFFERENCE

$p=0.05$ 2.11

$p=0.01$ 2.80

Although it is too early to draw firm conclusions from these trials it is satisfactory to note that the selections from which seed is being issued to the public compare favourably with other varieties under yield test.

Variety Trial at Scott Agricultural Laboratories, Nairobi

This trial was planted in May, 1956, and consists of nine varieties arranged in six randomised blocks of 20-tree plots.

Irrigation Trial

This trial was laid down in 1956 with the following objects:—

- (1) To compare economy of water use with economy of labour.
- (2) To study the effects on coffee yield of irrigating coffee at each of three seasons of the year.
- (3) To observe and record any physical or chemical changes in the soil following irrigation.

Main treatments

- (a) Irrigation towards the end of the Short Rains flood-flow period, December-early January.
- (b) Irrigation towards the end of the Long Rains flood-flow period, May-early June.
- (c) Irrigation during August—a “crop saver”.

Sub-treatments

- (o) Overhead irrigation.
- (g) Ground irrigation to ponds 4 ft. x 4 ft. around each tree.

Experimental layout

The time of irrigation is arranged in a 2 x 2 x 2 factorial design and the plots are split for the method of application. There are three replications. Each sub-plot consists of 20 trees.

The amount of water to apply

The deficit between the moisture evaporated and the rainfall received is calculated from the last occasion when the top ten feet of the soil profile were saturated. Irrigation is then applied to make up this deficit.

J. A. N. WALLIS,
Agricultural Officer (Investigations), Coffee Services.

ANNUAL REPORT OF THE PLANT PATHOLOGIST AND PHYSIOLOGIST, COFFEE SERVICES, 1956

General

The following articles were published during the year:—

“Leaf Rust”, *Coffee Board Bulletin*, p. 65, March, 1956.

“Control of Coffee Berry Disease in Kenya” (with K. Bock), *Nature*, Vol. 178, p. 217, 1956.

Physiology

GROWTH RECORDING

At the Coffee Research Station the full range of treatments is now being applied to the experiment. A booster pump was installed and regular irrigations were commenced at the end of the year.

The year was remarkable for the heavy rain which fell in January and February, which produced continuous growth during these months. In fact the growth was more than half as rapid as at the peak rate during the Long Rains proper. The January-February period is normally marked by almost complete lack of growth. There was the usual decline towards the end of the Rains in May-June and a normal minimum growth period in July to September, with a fairly well marked optimum again during the Short Rains in November.

The various treatments seem to have had relatively little effect. However, the multiple-stem trees reached their peak growth in the Long Rains over a month later than the single-stem trees. The effect of stripping of crop was to depress growth somewhat in the early part of the Rains relative to the cropping trees, no doubt the result of effects during the previous year. Shaded trees grew throughout rather faster than unshaded and although this effect on rate is relatively small, the final effect on the trees is very considerable. The leaves are larger and darker, internodal lengths greater and fewer lateral branches are produced. In the multiple-stem trees, the height of the new heads is nearly double that of the unshaded trees and in consequence the cycle will be much shorter.

At the Scott Laboratories, the general appearance of the curves was very similar to those from the Coffee Research Station, except that the single-stem trees show a sharper peak in the Long Rains and in this case the multiple-stem trees were growing more rapidly in the early part of the Rains and at the same rate, but less rapidly in the later part.

Recording of crop on the cropping trees has commenced but only a relatively small crop was harvested.

An experiment to determine the effects of nitrogenous manuring on growth was started at the end of February in collaboration with the Agricultural Chemist in whose report details of the treatments may be found.

MALEIC HYDRAZIDE TRIAL

This trial, which was commenced in 1954 on Riverglade Estate, Cherangani, near Kitale, aims at reducing vegetative growth towards the end of the rainy season to see if any increase in flowering and crop production will result.

There were no significant effects on yield in the 1955-56 crop but the overall trend suggests that a small depression of crop is produced by all the treatments, this being more marked with the July spraying than with the August or September sprays.

Plant Pathology

ANTI-LEAF-FALL SPRAYING

Investigations on this subject have been confined to the three field trials already in existence.

At Solai, the trial of time of spraying, concentrations and rates was concluded. It had been intended to record the 1956-57 crop, but a misunderstanding led to the harvesting of part of this, unweighed, by the estate and so the experiment had to be abandoned. The analysis of the final results of this experiment has not yet been completed.

At Kitale, the trial which is of similar design to that of Solai, produced its fifth crop. The September spraying produced the highest response this year, followed by the July and May sprayings, with no spraying producing the least, the effect of time being significant. There was also a significant interaction of copper per tree and rate, increasing copper per tree giving an increased yield at 3 pints per tree, but a decreased yield at 1 pint per tree. In a trial of this nature, the results in any one year are strongly affected by those in previous years and it is the effects over several years which are of importance.

The cherry weights in pounds per plot over the years 1952-56 are given in Table I.

TABLE I

TREATMENT	Cwt./acre Clean Coffee	Per cent Control
Control (T_0)	34.24	100.00
May spray (T_1)	43.40	126.75
July spray (T_2)	41.65	121.64
September spray (T_3)	39.82	116.30
2 per cent at 1 pint (C_1D_0)	43.43	118.08
1 per cent at 1 pint (C_0D_0)	39.02	114.00
$\frac{2}{3}$ per cent at 3 pints (C_1D_1)	40.38	117.93
$\frac{1}{3}$ per cent at 3 pints (C_0D_1)	38.68	113.00
Significant differences—		
5 per cent point	3.08	
1 per cent.	4.15	
0.1 per cent	5.52	

Significant differences— $T_0 < T_1^{***}$, T_2^{***} , T_3^{***}
 $T_3 < T_1^*$

With each spraying date, spraying has produced a highly significant increase over control. Spraying in May was better than in June but not significantly so, but was significantly better than September spraying. There were no significant differences due to concentration or rate, but there was a trend in favour of the higher concentrations, the 2 per cent at 1 pint per tree giving the best result.

In the trial of copper and non-copper anti-leaf-fall sprays at the Coffee Research Station, the second year's yields were very low and the tendency was for treatments which yielded higher than average last year to yield lower than average this year. The two-year yields, however, maintain the same trends as last year.

Leaf-fall was recorded continuously throughout the year and heavy leaf-fall occurred in July to September and again in November. All treatments produced less leaf-fall than the controls, the reduction being most marked with the Fernide treatment. Hormone (α -naphthalene acetic acid) spraying seems to have produced some control of leaf-fall this year, but it was still less effective than the copper sprays and dusts, there being no marked differences between these latter, except that the treatment with a second cuprous oxide spray at the beginning of the Short Rains gave less leaf-fall in January to March than the single spray in May did.

Spraying Machinery

The only machine tested during the year was the Kiekens Dekker Air-blast portable sprayer. This machine was kindly loaned to us by Mr. T. R. Jones, Research Mechanic at Kawanda Research Station, Department of Agriculture, Uganda. Observations on its construction, behaviour, droplet spectrum and cover produced on growing coffee were made. The frequency distribution diagram showed a fairly broad maximum covering the range 60 to 100 μ with a mode at 80 μ . The upper tail was relatively short the mass mean diameter being 172 μ . The spectrum of an Eclipse Warley "pneumatic" pump with a No. 3 nozzle (4/64") at 60 p.s.i. was also determined and gave a diagram with a steep peak with a mode at 42 μ and a long upper tail, the mass mean diameter being 268 μ .

A comparative test for cover was carried out on some rather thin multiple-stem trees under slightly windy conditions. A range of rates of $\frac{1}{2}$, 1 and 2 pints per tree were tried, eight replications on single-tree plots being used. Cover was estimated using rubenian acid printing and eye estimate against a series of standards.

Table II gives the results in arbitrary units.

TABLE II

				PINTS/TREE		
				$\frac{1}{2}$	1	2
Kiekens Dekker	..	..	..	248.9	294.8	332.4
Eclipse Warley	..	..	..	355.1	373.3	451.3

It was found that the Kiekens Dekker at 2 pints per tree was still not producing the cover that the Eclipse "Warley" produced at $\frac{1}{2}$ pint per tree. This somewhat surprising result would suggest that the Kiekens Dekker method of spraying is highly inefficient for coffee trees. However, conditions during the trial were not ideal and further work is needed to confirm or otherwise, these results, especially as coffee planters have been showing considerable interest in similar machines.

Some tests with copper sprays applied from the air suggested that certain insecticides impede the rubenian acid printing of copper deposits. Experiments were carried out with a range of insecticides and copper fungicides sprayed onto leaves in the laboratory. Confirmation that a combination produced this effect was obtained and the firm concerned was warned to advise against the use of this particular combination, as the possibilities were that the fungicidal efficiency of the copper spray would be impeded.

Leaf Rust (*Hemileia vastatrix*)

Leaf Rust (*Hemileia vastatrix*) developed to epidemic proportions during the year as had been predicted from the occurrence of infective weather in January and February. The outbreak built up, as usual, during the Long Rains to a maximum in August. Severe leaf-fall resulted and the consequent reduction in inoculum and the lack of infective weather during August and the greater part of September led to only a relatively mild further attack during the Short Rains. However, there was still a fair amount of inoculum on the trees at the end of the year.

The routine testing of Rust collections for race has been started, in most cases duplicate collections being sent to the Rust Research Centre, Oeiras, Portugal, for determination. A series of differential host varieties has been set up from local material pending the arrival of clonal material from Oeiras. In addition, the resistance of various seedling coffee varieties is being tested with the Rust races isolated.

Preliminary investigations were made on the factors influencing infection of coffee leaves by *Hemileia vastatrix* and of the methods which could be used in these studies. A technique of depositing dry spores on leaves, originated at Long Ashton Horticultural Research Station, was found to be very satisfactory for work with coffee Rust. The leaf to be inoculated is placed under a bell-jar on a vacuum table and the jar evacuated. A flat glass nozzle is connected by tubing to the bell-jar and the vacuum is allowed to be dissipated through this whilst passing the nozzle over a sporing Rust lesion. A cloud of spores is produced in the bell-jar and this is allowed to settle on the leaf for five to ten minutes. Using this method, it was confirmed that spores could only land on the upper surface of the leaf to which they adhere very strongly until water passes over the leaf when they are very easily removed. The normal method by which they reach the under surface of the leaf would appear to be by rain washing off the spores that have landed on the upper surface of the leaf and by splashing on lower leaves, droplets land on the under surface of the leaves above them. Penetration of a leaf is always via the stomata and these only occur on the lower surface of coffee leaves.

In view of this method of reaching the under surface of the leaves, some tests were carried out to see whether water passing over the upper surface of a leaf with a fungicidal deposit could pick up sufficient fungicide to affect germination of Rust spores. Leaves were sprayed on the upper surface with various fungicides (Burgundy, Perenox, Cupromox and Cuprokylt) and allowed to dry for 24 hours or more. They were then sprayed lightly with distilled water to run off and the water dripping from them was collected. With this, hanging drop cultures were made of *Hemileia* spores and germination observed. In all cases there was a very considerable reduction in the percentage germination as against controls of distilled water. For example, in one test an average of 88 per cent germination was found on four slides for water as against 10 per cent and six per cent respectively for water which had passed over Burgundy and Perenox deposits. The possibility, which these results suggest, of upper surface fungicidal deposits playing an important role in controlling Rust attacks, should be investigated in the field.

The use of cellulose acetate film casts of leaf surfaces for following germination of Rust spores *in situ*, another method in use at Long Ashton, was investigated and found to be very satisfactory for *Hemileia* investigations.

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Soil Nitrogen and Related Studies

This year has been one of consolidation followed by the initiation of a further series of experiments. Two new major field experiments were started, one is an attempt to follow the mineralization of different nitrogen fertilizers in the Kikuyu red loam coffee soil without the complicating presence of a coffee crop, i.e. under fallow conditions, but in the presence and absence of both organic and inert (stone) mulches. The second experiment comprises a comparison of fertilizer nitrogen effects on mulched and unmulched coffee (Napier grass mulch). Both ammonium sulphate and urea fertilizers are included and records of vegetative growth, Kjeldahl leaf nitrogen and crop yields are being taken. No results are recorded here as it is too soon to interpret the available data.

A short-term investigation into the influence of soil temperature (in the field) on nitrate and ammonia nitrogen formation, was completed during February and March. Soil temperature records were obtained by the electrical resistance technique using thermistors which could be placed at a given depth very accurately. The area used for this experiment had been mulched fallow for five years prior to the commencement of the experiment and uniformity of total nitrogen distribution in the topsoil was assumed. A comparison of some of the treatment means (*see* Table I) suggests that a real increase in nitrate nitrogen was found with the treatment (X) having the highest average soil temperature (measured at 2.10 p.m. daily), but this does not take into consideration the possible upward movement of nitrate from underneath a soil surface devoid of mulch. The mean soil moisture figures show that this treatment also had the lowest mean soil moisture value.

TABLE I

TREATMENT	NO ₃ -N.	NH ₃ -N.	H ₂ O	Soil Temp.
	(ppm)	(ppm)	(per cent)	(°C.)
X.—0.4 cm. soil removed; no mulch	32.8	4.66	22.5	37.2
Y.—0.4 cm. soil present as a soil mulch ..	16.7	3.02	27.9	28.6
Z.—0.4 cm. soil removed; stone mulch	14.2	3.41	34.6	27.9
L.S.D's (Means of 20)	9.46*; 18.82***	0.63*	2.7*; 5.3***	—

NOTE.—Soil sample depth 4-8 cm.

This type of experiment has to be repeated using a marker mechanism in the soil to follow nitrate nitrogen movement.

An experiment to try to determine the influence of coffee roots, during an active growth period, on nitrogen mineralization trends and the quantities of nitrate and ammonia nitrogen present in the soil, was not conclusive. Further experimentation and improvement of the field technique for isolating columns of soil *in situ* is desirable.

Before commencing a full-scale trial to investigate the influence of fertilizer nitrogen applications, in the presence and absence of mulches, on leaf nitrogen content, growth and crop yield, a small preliminary trial was put down in the Short Rains 1955. This consisted of a comparison, in terms of Kjeldahl leaf nitrogen content only, of none versus 4 cwt. per acre in one application versus 4 cwt. per acre in four equal applications, of ammonium sulphate. There were five replications and the results are summarized in Table II.

TABLE II—NITROGEN IN DRY MATTER OF 1ST PAIR OF FULLY HARDENED LEAVES
Short Rains 1955

SAMPLING TIME	TREATMENT			Means (of 15)
	(1)	4 cwt. S/A.	4 x 1 cwt. S/A.	
1. 29-10-55 ..	2.076	2.091	2.005	2.057
2. 9-11-55 ..	2.071	2.071	2.072	2.071
3. 18-11-55 ..	1.984	2.057	1.888	1.977
4. 28-11-55 ..	2.105	2.175	2.007	2.096
Mean (of 20) ..	2.059	2.099	1.993	
L.S.D's	No significant difference			0.072*

NOTES—

(1) Nitrogen is expressed as per cent dry matter, and includes $\text{NO}_3\text{-N}$.

(2) Fertilizer treatments were applied on 18/10/55, and three subsequent quarters of the 4 x 1 cwt S/A per acre treatment on 29/10/55, 8/11/55 and 18/11/55.

The only statistically significant effect was with the time of sampling; rainfall was poor (4.85 in. from 1st October to 28th November, 1955) and observed vegetative growth was slight despite the fact that the crop had been picked and the trees left in a suitable condition to make growth.

As a check, in case rainfall and growth had been inadequate for effects on leaf nitrogen to be detected, three sets of leaf samples were collected during the following Long Rains period—23/4/56, 19/5/56 and 18/6/56—but again there was no significant effect resulting from the nitrogen fertilizer treatments. However, the sampling times were significantly different with mean values of 2.121, 2.160 and 2.069% N in dry matter. (L.S.D.=0.042% * N.) Since the leaf nitrogen values are considered to be satisfactory for periods of rapid growth, the effect of the fertilizer may have been to produce more leaf pairs without influencing significantly the nitrogen content in the dry matter. This aspect will be examined in the large-scale trial which has been started.

Leaf samples have been collected at intervals during 1955 and 1956, processed in the laboratory, and sent to the Colonial Products Laboratory, Imperial Institute, London, for full spectrographic analysis. The samples have been collected from the Plant Pathologist's shade trial experiment area for the purpose of studying mineral nutrition trends and levels in the coffee leaf in relation to single- versus multiple-stem pruning and artificial shade versus no shade. Sub-samples have been retained in the laboratory and analysis of leaf nitrogen has been completed, but the other results have not been received from London yet.

During the Short Rains 1955 some preliminary tests were made with various spray concentrations of urea fertilizer nitrogen on mature multiple-stem coffee.

1. A series of spray concentrations ranging from 100 lb. Urea/100 gal. acre, 50 lb. Urea/100 gal., 25 lb. Urea/100 gal., 10 lb. Urea/100 gal., 5 lb. Urea/100 gal., and 1 lb. Urea/100 gal. were applied at a rate of $1\frac{1}{2}$ pints per tree with the following results:—

100 lb. Urea/100 gal.	..	..	Severe scorch of young foliage and where solution collected on leaf edges.
50 lb. Urea/100 gal.	..	..	As above but with less severity.
25 lb. Urea/100 gal.	..	..	Negligible damage—occasional slight scorch on very young growth.
10, 5, 1 lb. Urea/100 gal.	..	..	No effects observed.

At 25 lb. or less no adverse effect was noted on green cherry or spiking or flowers.

2. In a second test, 25, 20, 15 and 10 lb. Urea/100 gal. water were compared. Again a very slight degree of scorch was noted at the 25 lb. Urea rate, but none was observed at lower concentrations.

3. A spray combination of a proprietary 50 per cent copper formulation at the tonic level and 25 lb. Urea/100 gal. water/acre, was applied. There were no adverse effects observable on the foliage resulting from this combination and from that point of view there is nothing against spraying the mixture on to coffee. Whether the Urea interferes with the efficiency of the copper spray is another matter. No chemical interaction seems likely, but a physical effect or antagonism, could be present.

4. In an endeavour to reduce the volume of water required for Urea spraying, a low volume/high concentration spray was applied with a knapsack power turbine sprayer. 150 lb. Urea/100 gal. were applied at a $\frac{1}{4}$ pint spray per tree. The ultra-low-volume spraying ability of the machine was not good and some very severe scorch was subsequently observed where droplets had coalesced on the leaf surface and run down on to the edge of the leaf. A very efficient type of sprayer will be necessary for this type of application.

LABORATORY INCUBATION STUDIES ON THE KIKUYU RED LOAM SOIL

Further experiments to study the relationship between soil moisture and the mineralization of natural soil nitrogen have been carried out in parallel with the field studies. The study of soil moisture influence on nitrogen mineralization at or below the permanent wilting percentage, which were summarized previously (*Ann. Rept. Dept. Agric., Kenya, 1955, Pt. II 107-108*), has been fully reported in a paper published in the *J. Agric. Sci.*, 1957, 49, 100.

It has been demonstrated previously that under field conditions natural $\text{NO}_3\text{-N}$ values in the top 0-18 in. are low during the greater part of the major rainfall periods, when the soil is wet and the coffee growing actively, and that in the intervening dry periods when soil moisture levels decrease, $\text{NO}_3\text{-N}$ values rise. This is of course a generalization which holds true subject to the influence of appreciable rainfall during the so-called dry periods.

Under laboratory incubation conditions, the more moisture there is in the soil between the permanent wilting percentage and field capacity levels, the greater the $\text{NO}_3\text{-N}$ mineralization and the greater the total $\text{NO}_3\text{-N}$ content of the soil, at the end of a 32-day incubation period. Thus, it might be argued, that under field conditions low $\text{NO}_3\text{-N}$ values during the rains are attributable largely to the leaching of $\text{NO}_3\text{-N}$ down through the profile and to uptake by the coffee; accumulations of $\text{NO}_3\text{-N}$ in the dry period following might then be attributed to rapid mineralization of nitrogen whilst the soil is drying out coupled with a lack of leaching through the profile and little or no uptake by the coffee tree. In the first case this presupposes (a) that the degree and rate of nitrification in the field is high under wet soil conditions (as found in the laboratory incubation studies) and (b) that the soil is not changed in any appreciable manner through air drying, and even storage, prior to its use in the controlled laboratory tests.

These two points are being investigated under controlled laboratory conditions.

(a) The influence of maintained soil moisture versus drying out of the soil:—

A short- and long-term experiment were carried out and a brief summary of the $\text{NO}_3\text{-N}$ results from one of them is given in Table III.

TABLE III— $\text{NO}_3\text{-N}$ IN OVEN DRY SOIL (PPM)
Moisture Level

MOISTURE	P.W.P.	$\frac{1}{2}$ F.C.	F.C.	Mean (of 18)
Drying out ..	12.1	32.5	43.8	29.5
Maintained ..	22.0	41.6	58.7	40.8
Mean (of 12) ..	17.1	37.1	51.2	
L.S.D's ..	5.9*		11.0***	4.8*; 9.0***

TIME INTERVALS				Drying out	Maintained	Means (of 12)
8 days	..	..	..	27.6	30.7	29.1
16 days	..	..	..	31.0	39.1	35.1
32 days	..	..	..	29.7	52.6	41.2
Means (of 18)	..	..	..	29.5	40.8	
L.S.D's	..	..	..	4.8*; 9.0***		5.9*; 11.0***

L.S.D. Interaction Time Intervals x Drying out and Maintained = 8.3*; 11.4**

NOTES—

P.W.P. = Permanent Wilting Percentage; $\frac{1}{2}$ F.C. = half field capacity and F.C. = field capacity moisture levels.

In the second experiment the mean values (of 20 replications) after ten weeks incubation at a commencing moisture content equal to that of field capacity were F.C. maintained = 89.1 ppm $\text{NO}_3\text{-N}$, F.C. Drying out = 48.0 ppm $\text{NO}_3\text{-N}$. (L.S.D. = 6.0***)

These results suggest that provided the topsoil moisture level is equal to or greater than the permanent wilting percentage value ($\approx$ 21 per cent oven dry soil), then more $\text{NO}_3\text{-N}$ will be produced if the moisture level is maintained and secondly that some $\text{NO}_3\text{-N}$ will be produced during drying out of the soil if the initial moisture value is greater than the permanent wilting percentage. Thus, in the field, dry season accumulation of $\text{NO}_3\text{-N}$ in the soil takes place because mechanisms for removal, i.e. by leaching or by plant uptake, do not keep up with formation and as the result of the upward migration of $\text{NO}_3\text{-N}$ which may take place (*see* earlier in this report) into the immediate topsoil (0–3").

(b) *The effects of predrying soil samples before incubation.*—This investigation is under way but it is too early yet to produce a summary of results. Suffice it to say that any appreciable degree of predrying a soil seems to influence very markedly the $\text{NH}_3\text{-N}$ and hence the $\text{NO}_3\text{-N}$, produced under incubation conditions when the results are compared with the same moist field soil incubated immediately after sampling. Both $\text{NH}_3\text{-N}$ and $\text{NO}_3\text{-N}$ results are very much higher, the former during the early stages and the latter at the end of a 32-day incubation period.

Magnesium Nutrition of Coffee

During the Long Rains a visual deficiency condition was observed on mature bearing coffee in some of the long-term mulch and soil regeneration trial plots on the Coffee Research Station. A joint investigation of the condition both in Kenya and Uganda coffee was undertaken in collaboration with Dr. E. M. Chenery of the Department of Agriculture, Uganda. A report of this study has

been prepared for publication and details of the findings are not given here. The results may be summarized, in so far as the Arabica coffee industry in Kenya is concerned, as follows: "The magnesium deficiency syndrome for Arabica coffee has been described in detail. The distribution of magnesium and potassium in branches of trees treated and not treated with Napier grass mulch are presented. The critical level of magnesium below which the syndrome is likely to occur and the leaves to drop prematurely, is about 0.20 per cent D.M. although cases have been quoted where the magnesium content is below 0.1 per cent D.M. The critical ratio of potassium to magnesium in leaves is about 10 to 1.

Mulching treatment with Napier grass has a strong tendency to induce magnesium deficiency by supplying an excess of antagonising potassium to the soil. Iron chlorosis is often associated with the deficiency. Frequently it was found that magnesium levels in cherry on deficient trees were similar to, or even greater than, those found in healthy trees, thus often tending to exaggerate the deficiency. The deficiency occurs mainly in the older leaves in whose axils cherries are developing."

The benefits of Napier grass mulching in terms of crop yield are such that the correction of this condition is now under investigation with magnesium fertilizer salts. A possible means of alleviating the onset of the condition lies in finding a grass with suitable mulching potential which has a lower potassium content than Napier grass. This latter material is a luxury consumer of potassium when grown on the fertile Kikuyu red loam soils which are rich in naturally available potassium.

A survey of leaf potassium and magnesium values was carried out in mature bearing coffee during August–September. A few representative estates were chosen at random within the Thika, Ruiru and Kiambu areas. Unfortunately leaf samples were all collected from the current 1956 wood and none were taken from 1955 wood. This resulted in a less sensitive range of analytical values as noted earlier in this section. Evidence, both visual and analytical, of magnesium deficiency, or imbalance, was obtained in all districts and was particularly noticeable in heavily bearing multiple stem as distinct from single-stem coffee, and in heavily shaded coffee (*Grevillea* sp.), in the Kiambu area, as opposed to unshaded coffee.

The small survey trial which began in 1954 (ref. *Ann. Rept. Dept. Agric., Kenya*, 1954, Pt. II, 132) was continued. Residual leaf samples from the 1955 collections were analysed together with all 1956 samples, for potassium, calcium and magnesium. The trial will be mulched with Napier grass in 1957 in view of the results from the work reported earlier in this section.

The comparative yield data over three years (1954–1956) are control, 8.5 cwt. clean coffee per acre per annum and magnesium fertilizer treatment, 9.5 cwt. clean coffee per acre per annum, representing an apparent average annual yield increase of 1 cwt. of clean coffee per acre per annum. This figure is not statistically significant.

The leaf analysis data for 1955 and 1956 do not show significant leaf composition differences arising from the application of magnesium fertilizer. In the light of recent work this may be because the leaf samples taken were too young, i.e. the first pair of fully hardened leaves on a primary. It has been shown (see Table IV) by detailed branch analysis that the old leaves on the bearing wood, particularly with crop present in the axils, show wider ranges of leaf magnesium in the presence of sub-optimal magnesium nutrition.

TABLE IV—BRANCH ANALYSIS OF BEARING AND NON-BEARING MATURE MULTIPLE STEM COFFEE (VAR. SL.28)

Mg deficient leaves present

Nodes			Sample	Per cent K.	Per cent Mg.	K:Mg ratio
			1956, Non-bearing wood—			
1-5	..	..	Leaf	2.12	0.41	5.1:1
6-10	..	..	Leaf	2.35	0.25	9.4:1
			1955, Bearing wood—			
11-16	..	..	(a) Leaf	3.10	0.07	44.3:1
			(b) Crop (Green cherry)	2.18	0.23	—
17-21	..	..	(a) Leaf	3.98	0.13	30.6:1
			Crop (Green cherry) ..	2.45	0.26	—

No visual deficiency, v. light crop

Nodes			Sample	Per cent K.	Per cent Mg.	K:Mg. ratio
			1956, Non-bearing wood—			
1-4	..	..	Leaf	2.35	0.41	5.7:1
5-7	..	..	Leaf	2.90	0.37	7.9:1
			1955, Bearing wood—			
0-8	..	..	Leaf	2.87	0.31	9.2:1
9-17	..	..	Leaf	2.75	0.31	8.8:1
			Crop (Green cherry) ..	2.36	0.29	—

NOTE.—Analysis by G. T. Chamberlain, Spectrochemist, E.A.A.F.R.O.

Although treatments did not significantly effect leaf composition there were significant differences at different sampling times during 1956, and the mean results are noted in Table V.

TABLE V

ELEMENT (Per cent in Dry Matter)	1	2	3	4	5	6	7	8	9	Mean (of 90)
	24-4-56	25-5-56	26-6-56	25-7-56	27-8-56	26-9-56	26-10-56	26-11-56	27-12-56	
Potassium	2.99	2.41	3.04	2.42	2.42	2.63	2.41	2.70	3.13	2.68
L.S.Ds. ..		0.20*		0.27**						
Calcium ..	0.97	0.96	0.94	0.84	1.08	1.04	1.00	1.16	0.82	0.98
L.S.Ds. ..		0.09*		0.12**						
Magnesium	0.41	0.38	0.36	0.37	0.41	0.44	0.46	0.56	0.32	0.41
L.S.Ds. ..		0.04*		0.05**						

The arrow over the sampling times represents the presence of crop, from pinhead to fully ripe. From the third (end of Long Rains period) to the seventh (beginning of Short Rains period) sampling time inclusive, rain was spasmodic, and growth small. Thus, during crop maturation in the dry months potassium levels fall, whereas calcium and magnesium levels tend to rise. It is too early yet to attempt to interpret these trends with any degree of certainty.

Chemical Weed Control in Coffee

Further progress was made with this work during the year, and the results have been recorded in a series of publications, *vide*, *Coffee Board of Kenya Monthly Bulletin*, 1956, 21, 249; *Pesticides Abs. and News Summ.* Sect. C. 1956, 2, 128.

Dowpon (Dalapon formulation) emerged as a potential material for the control of couch grass (*Digitaria scalarum*), and was particularly effective when applied with 2, 4-D material, in controlling a mixed weed growth of mono and dicotyledonous weeds including couch grass. No chemical tainting of coffee liquors prepared from coffee harvested in Dowpon treated plots was found.

Production of Napier Grass on Vlei Soils

This trial which has been described previously in reports (*see Ann. Rept. Dept. Agric., Kenya*, 1954, Pt. II, 137 and 1955, Pt. II, 110) was continued. A summary of the yields for 1956 is given in Table VI.

TABLE IV—NAPIER GRASS YIELDS (TONS GREEN MATTER/ACRE), LONG RAINS (L.R.) 1956, SHORT RAINS (S.R.) 1956

TREATMENT	YIELD (MEANS OF 3)		YIELD EFFECTS (MEANS OF 12)	
	L.R.	S.R.	L.R.	S.R.
(1)	8.68	5.06	—	—
N (1 cwt./acre ammonium sulphate)	10.90	6.27	+7.51	+1.58
P (1 cwt./acre double super-phosphate)	11.42	7.04	+6.20	+2.25
C (Residual from 1955) ..	14.82	7.69	+5.34	+2.34
NP	24.86	9.80	+3.96	—
NC	19.71	9.32	—	—
PC	16.58	9.90	-2.14	—
NPC	26.09	10.63	—	—
L.S.D's	3.69*	2.43*	1.84*	1.21*
	5.12**	3.37**	3.56***	1.68**

As in 1955, the phosphorus fertilizer and (residual) cattle manure treatments have significantly increased yields. Nitrogen fertilizer also increased yields significantly in both rains although in 1955, nitrogen did not influence the yields of the post establishment cut. Yields are low and not very economic in the absence of cattle manure or of phosphorus plus nitrogen fertilizers.

When cutting the crop after the Long Rains it was observed that the incidence of leaf fungus infection (*Beniowskia sphaeroidea*) appeared to vary among the treatments. The incidence was scored visually in a simple manner and subsequently the results were analysed statistically. Nitrogen fertilizer had no significant influence, phosphorus and cattle manure treatments reduced the degree of infection significantly whereas an interaction of nitrogen fertilizer with cattle manure increased significantly the infection.

Comparison of Types of Phosphate on Kikuyu Red Loam Soil

These trials, laid down in established Napier grass, in established pasture grass species and for a cropping system of Long Rains silage maize followed by

Short Rains beans, were started in 1955 (ref. *Ann. Rept. Dept. Agric., Kenya*, 1955, Pt. II, 116). The results obtained during 1956 are summarized briefly in Tables VII, VIII and IX.

TABLE VII—NAPIER GRASS YIELDS (TONS GREEN MATTER/ACRE)

	(1)	Ps.	Phr.	Pbs.	Means (of 12)
LONG RAINS—					
(1)	21.5	27.3	26.1	32.4	26.8
N.	26.7	32.1	27.2	25.6	27.9
Means (of 6) ..	24.1	29.7	26.6	29.0	—
SHORT RAINS—					
(1)	12.0	15.5	13.1	14.8	13.8
N.	14.1	15.9	12.8	14.0	14.2
Means (of 6) ..	13.0	15.7	12.9	14.4	—

NOTES—

1. N=1 cwt./acre ammonium sulphate.
2. Ps=100 lb./acre double superphosphate (42 lb. water soluble P_2O_5).
3. Phr=145 lb./acre hyperphosphate reno. ($\approx$ 42 lb. citric soluble P_2O_5 .)
4. Pbs.=292 lb./acre basic slag. ($\approx$ 42 lb. citric soluble P_2O_5 .)

No statistically significant yield results were obtained although an inspection of the mean yields for phosphorus fertilizers suggests again that double superphosphate (42–44% P_2O_5) and basic slag have been beneficial.

TABLE VIII—SILAGE MAIZE YIELDS (TONS GREEN MATTER/ACRE) L.R. 1956
White Haricot Bean Yields (Threshed beans, lb./acre) S.R. 1956

	(1)	Ps.	Phr.	Pbs.	Means (of 12)
LONG RAINS, MAIZE—					
(1)	11.07	17.68	15.22	19.58	15.89
N	10.31	17.58	15.27	18.22	15.35
Means (of 6) ..	10.69	17.63	15.25	18.90	—
L.S.D's ..	Means of 6=2/15*; 2.98**				
SHORT RAINS, BEANS—					
(1)	361.9	504.6	445.1	519.7	457.8
N	422.48	490.5	424.3	447.0	446.0
Means (of 6) ..	392.1	497.5	434.7	483.3	—
L.S.D's ..	Means of 3 (in table)=90.2*; 125.1**; Means of 6=63.6*; 88.3**				

NOTE.—Fertilizer treatments similar to those noted under Table VII.

All the phosphorus fertilizers have increased the maize yields, with double superphosphate and basic slag both better than hyperphosphate reno. Ammonium sulphate at 1 cwt. per acre has not increased the yields.

The fertilizer treatments were residual only for the bean crop in the Short Rains. The residual effects of double superphosphate and basic slag have increased

yields significantly. The residual nitrogen effect is not significant and has in fact produced an apparent overall slight decrease in the presence of the residual phosphorus fertilizers.

TABLE IX—PASTURE GRASS YIELDS (TONS GREEN MATTER/ACRE)

TREATMENTS	MEANS OF 3 GRASS SPECIES*	
	Long Rains	Short Rains**
(1)	3·63	3·92
Ps.	3·76	3·46
Pbs.	3·94	4·11
Phr.	4·68	4·99

Notes—

* *P. maximum* var. *trichoglume*, *Bothriochloa insculpta*, and *Setaria* sp. ex Nandi.

** The phosphorus fertilizer treatments were residual only in the Short Rains. Rates of application as noted under Table VII.

There were no significant yield differences attributable to fertilizer treatments in either rains, although hyperphosphate reno fertilizer continued the trend shown in the 1955 results, and produced the highest yield.

Miscellaneous

During the year a number of field trials were laid down from which no data have yet been recorded.

An exploratory trial to determine the effect of chelates on the establishment and subsequent production of coffee, was started. In it, individual trees with and without any cattle manure in the planting hole, were treated with copper, zinc, manganese, iron and magnesium chelates (Messrs. Geigy's "Sequestrene" materials), a commercial by-product of iron lignin sulphonate and a fritted glass trace element material. Trunk girth measurements will be recorded in the early stages followed by crop records from the third year.

The trial with Krilium soil conditioner in the coffee nursery, previously reported in *Ann. Rept. Dept. Agric.*, 1955, Pt. II, 115, was replanted for the second time. Unfortunately the seedlings failed and a further planting will be made in these plots during 1957.

In collaboration with Mr. H. R. Evans, Senior Assistant Horticultural Officer, a trial with chelates applied to the soil at the time of planting pineapples was also put down. This trial includes treatments with iron manganese and magnesium chelates, iron lignin sulphonate and a fritted glass trace element material.

ACKNOWLEDGMENTS

I would particularly like to acknowledge the help of Mr. C. R. Devonshire, Liquorer, Coffee Board of Kenya, and Mr. G. T. Chamberlain, Spectrochemist, East African Agriculture and Forestry Research Organization.

Publications

(1) The influence of fertilizers and manures on the pH reaction of a coffee soil. *E. Afr. agric. J.*, 1956, 22, 76.

(2) Rapid Kjeldahl Nitrogen digestion of coffee-leaf material by the Permanganate method. *The Analyst*, 1956, 81, 316.

(3) The effect of rainfall and other factors on coffee production and yields in Kenya, 1947-1955 (with A. R. Melville). *Monthly Bull. Coff. Bd. Kenya*, 1956, 21, 96.

(4) Recent results of experiments with chemical weedkillers in coffee. *Coffee Bd. of Kenya Monthly Bull.*, 1956, 21, 249.

(5) Chemical control of weeds in coffee (a further short report). *Pest Abs. and News Summ. C.*, 1956, 2, 128.

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COFFEE BERRY DISEASE RESEARCH UNIT ANNUAL REPORT, 1956

The work of the Coffee Berry Disease Research Unit started in May, 1955, at the Coffee Research Station at Jacaranda with the arrival of Mr. K. R. Bock. During the following six months he carried out field trials and a preliminary laboratory study. (*E.A. Agricultural Journal*, Vol. XXII, No. 2, October, 1956.) In November, 1955, Dr. M. Roberts and Dr. J. Nutman arrived. Limited laboratory accommodation was obtained by January, 1956, by the courtesy of the Director of the E.A. Tsetse Research Organization, but full accommodation was not available until May, 1956. Laboratory equipment arrived in May and in June, 1956.

FIELD EXPERIMENTS

The carrying out of the field experiments has been undertaken by Mr. Bock, with the assistance of Mr. I. Leveiseur.

The 1955 field trials had shown that an organo-mercurial compound (phenyl mercuric acetate) gave some indication of possible control of coffee berry disease: tests of this fungicide, therefore, were the main object of the 1956 programme.

After a survey of the affected areas both east and west of the Rift, five sites were selected for field trials; these were two estates in Upper Kiambu, one in North Lumbwa, one in the Nandi Hills, and one in Cheregani. The experimental design, a 2⁵ confounded block trial, was the same at all sites. It was intended to spray five times during the season, starting with a pre-blossom treatment. Work began, however, too late for a true pre-blossom application to be made, while the number of applications was eventually increased to seven. Other trials, designed to compare the persistence of two fungicides and the effect of varying frequency of treatment, were sited on two Upper Kiambu estates, and other experiments in the form of randomized block trials were carried out at three sites west of the Rift. One of these was designed to test four proprietary fungicides thought to be of possible value on the basis of laboratory studies. The Nandi Hills experiments were later extended to Kapsabet where, with the co-operation of the District Agricultural Officer, treatments with phenyl mercuric acetate were superimposed on an existing varietal trial. In June work was extended to the Nyeri District, where randomised block trials were laid out to study the effect of treatments on mid-season and ripe cherry infection.

Results are, as yet, incomplete but there are indications that an eventual economic control may be possible with organo-mercurial compounds, and also that the treatments before and after flowering are of great importance. In this connexion the abnormal flowering experienced over the coffee-growing areas of Kenya during the year has added greatly to the difficulties of the work and, to some extent, to the assessment of the results.

LABORATORY AND FIELD STUDIES OF THE PATHOGEN

This phase of the work has been undertaken by Dr. Roberts and Dr. Nutman.

Following a general study of the disease in the field and of the fungus in the laboratory, attention has been concentrated on the following main lines of investigation:—

1. A technique for the laboratory assessment of the efficiency of various fungicides: this screening method is now available as a routine check

on any new chemical before it is tested under field conditions; saving of time can thus be effected since a preliminary evaluation of a new fungicide cannot be made in the field under less than one crop season.

2. An investigation of the importance of *Colletotrichum coffeanum* as a pathogen of the flowers showed that in some instances losses of up to 90 per cent could occur, while an average value for flower losses in lightly affected plantations was around 15 per cent. Largely as a result of this, emphasis in the spraying programme has been placed on early application, a decision which has been justified by field results. Field observations confirm laboratory work on the importance of this phase of the disease as this comprises not only flower losses, but the subsequent infection and destruction of the very earliest stages of the developing fruit.
3. A field study of the pathogen indicated that the "overwintering" stage occurs in the tissues external to the developing phellogen and, in particular, in the stipular bracts at the leaf bases. On both stem and bract the fungus can spore freely under suitable conditions, and it can also directly invade the developing crop from either, thus initiating fresh outbreaks.
4. The pathogen can, under certain conditions, invade twigs before phellogen formation occurs, and it can also, sometimes, penetrate the phellogen: in these cases it can penetrate deeply into the tissues, producing a dieback identical with that described as "Elgon dieback". In the laboratory symptoms of Elgon dieback can readily be reproduced by inoculation with spores from berries infected with Coffee Berry Disease; further, the fungus isolated from all cases so far examined of natural Elgon dieback can cause typical disease symptoms when re-inoculated on berries.
5. A detailed investigation is in progress of the conditions under which the pathogen can cause infection. The object of this is two-fold: firstly, more detailed knowledge should enable applications of fungicide to be made at times when they are most likely to be effective; secondly, it is hoped to determine by such means whether there are any climatic limits within which the disease may be expected to present, sooner or later, a serious problem, and outside which less serious, or comparatively infrequent, losses can be anticipated. Some progress has been made with this investigation. The temperature relations of growth, spore production, germination, and infection have been determined. The temperature range is fairly narrow, the extreme limits being 62° F. and 79° F. with a sharply defined optimum at 72° F. (22° C.). Germination and penetration of the berry can be remarkably rapid, there being appreciable germination in as little as 2½ hours under optimum conditions. The relation between germination and actual infection is still being studied, but there are indications that penetration can occur in as little as three hours. The spores of the pathogen are very readily killed by desiccation, the germinating capacity on the surface of berries being reduced by more than 70 per cent after four hours' exposure in the laboratory. On the other hand, a small proportion of the spores can apparently survive unfavourable conditions of humidity for as long as thirty hours, and can cause limited infection. Another point of interest is that spores from the lesions on ripe berries (the so-called "brown blight" stage) have a greater germination capacity, and are more infective than

are those from green berries. The significance of this is that the most likely common means of spread of the fungus is carriage on the persons of workers in the plantation, and, during picking, spores from ripe berries are the ones most likely to be transported in this manner.

6. Field observations have made it clear that, in the main centres of infection, the disease has increased both in range and intensity, and heavy losses of crop are being experienced. As an example, one recent sample from an upper Kiambu plantation showed a 40 per cent infection of young green berries, while plantations hitherto free, or only mildly infected, are now being attacked. Similarly, some serious outbreaks have occurred in one African Land Unit where the disease has been observed causing appreciable loss at an altitude of 5,200 feet.

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GRASSLAND RESEARCH—ANNUAL REPORT FOR 1956

Introduction

The staff position during the year has been satisfactory, with all officers released from the security forces, and very few officers away on long leave.

The Grassland Research Organization is now fully staffed with Pasture Research Officers, and its activities cover the following zones: Kitale, for the high rainfall mixed farming areas of medium altitude; Molo, for similar areas of high altitude, e.g. up to 9,000 ft.; Katumani, near Machakos, for the semi-arid African and European areas; and Marigat, which is the headquarters for work in the African semi-arid, overgrazed areas in the Baringo Reserve. The headquarters for the ranch research work in the European semi-arid areas has not been chosen yet, and the establishment of a fully equipped ranch research station will have to await the availability of more funds under the Development Scheme. Meanwhile the work will consist of co-operative experiments carried out on selected ranches, in conjunction with farmers.

There are three main principles underlying the programme of work on the stations. These are (a) to produce as much high quality herbage as possible the whole year round, (b) to raise the level of soil fertility where it is low, and to maintain it where it is high by good grassland management, and (c) to develop a sound farming system on the basis of the experimental work which has been carried out.

To attain these objects, the work of the Kitale main station is organized accordingly, each officer having his allotted task in the evaluation of species from a particular point of view, and the experimental programme is designed to deal with all the important aspects of grassland research. These are:—

- (a) The plant introduction and nursery work, to sort out promising new species and strains.
- (b) Herbage agronomy work, which is the further evaluation of species and strains under different systems of management and manuring, and experiments on ley establishment.
- (c) The effect of grasses and legumes and of different systems of management on soil fertility.
- (d) The investigation of nodulation and nitrogen fixation in herbage legumes.
- (e) Experiments on the management and improvement of natural grassland.
- (f) Experiments on seed production, and work on the bulking up of seed of promising new herbage plants.
- (g) The final evaluation of herbage species and strains, and methods of management, by comparing the production of meat and milk derived from them. This last item is of particular interest to farmers, as they wish to know the economic value in terms of meat and milk production from herbage plants and management systems, and these are the last in the series of tests carried out on the grasses and legumes.
- (h) As experimental results become available, they are incorporated into a series of experimental rotations, first on a small scale, and then increasing in size. There will be five of these on the station altogether, the acreage of each course varying from one acre on the smallest to fifteen on the largest. This system ensures small-scale field trials of new results or ideas, which can then later be tested further and confirmed on a larger field scale. This method helps to avoid costly or spectacular mistakes on a large scale.

- (i) Another branch of the work is the production of foundation seed and mother seed of herbage plants for the seed certification scheme. As the number of species in the scheme increases, this work will take up more of our resources in staff and funds. It is, however, of great importance to the farming community in supplying them with good seed of authentic strains of grasses and clovers for farm use.
- (j) The co-operative experiments programme is designed to test our various grasses and clovers under a wide variety of conditions, by growing them on farms in the Trans Nzoia and Uasin Gishu areas. It also has the merit of showing farmers which species and strains can be grown on their land.
- (k) Throughout all the work mentioned above, the Pasture Research Chemist assists by means of advice and analyses and other determinations to ensure that the best possible use is made of these resources.

Kitale Grassland Research Station

WEATHER AND RAINFALL

The rainfall on the station for the year 1956 was 45.80 inches, approximately equal to the mean rainfall figure, though on one corner of the station another rain-gauge recorded nearly 50 inches. The year was an unusual one in that a considerable amount of rain was recorded in the usually dry months of January, February and March, and there was not much of a dry season. The rainy season months produced adequate rain, with rather drier weather in June, and the rains continued well into October. It was a satisfactory rainy season for work on field experiments.

RAINFALL TABLE

MONTH	1956		1955		1954	
	Rainfall (inches)	No. of days	Rainfall (inches)	No. of days	Rainfall (inches)	No. of days
January ..	2.12	9	1.76	6	0.24	2
February ..	3.10	6	1.23	6	1.17	3
March ..	2.56	7	0.45	4	3.26	7
April ..	5.75	19	3.49	17	4.80	15
May ..	6.85	21	4.44	13	5.52	22
June ..	2.70	18	3.19	14	4.59	16
July ..	4.72	21	4.58	22	5.31	18
August ..	7.50	21	6.18	21	5.71	25
September..	4.46	18	6.28	24	5.28	14
October ..	4.73	17	2.83	14	1.69	12
November..	0.56	3	1.42	12	1.45	5
December ..	0.75	7	4.87	11	2.32	6
TOTALS	45.80	167	40.72	164	41.34	145

PLANT INTRODUCTION AND NURSERY WORK

This year the nursery has contained about 1,000 different plots of grasses, legumes and herbs under preliminary trial and observation, and 500 of these were planted at the beginning of the season. The total number of different species represented in the nursery was 220.

A considerable number of new varieties of the species in common use such as Rhodes grass, Molasses grass, Star grass, Guinea grass and Lucerne have been introduced for trial, with a view to finding better strains than those now available.

Setaria splendida, which is a highly productive fodder grass of good quality, of which we have over a dozen different types, is being examined in order to find a strain which produces plenty of viable seed and which breeds fairly true to type. At present this species has to be planted from roots, and is very variable if planted from seed, which are disadvantages. It is hoped that some of the strains which already seed well will be found to give viable seed and breed true to type. Previous tests here with some of the types have produced a negligible amount of viable seed.

Sainfoin (*Onobrychis sativus*), a forage legume grown in the south of England, has given promising results in the nursery over three years, and will now be tested on a larger scale to see what its possibilities are in the field. Unlike lucerne, it seems to be almost unaffected by leaf spot diseases, and it is considered to be of very good quality as a food for livestock. Anyone interested in growing it must bear in mind that it needs its own particular strain of bacterium for nitrogen fixation, and that it does not normally use the bacteria belonging to any of the other legume groups.

Ronpha grass, which is probably a hybrid between two species of *Phalaris*, and originates from South Africa, has been planted up in the nursery, but although a few plants have become quite well established it is too early yet to say if its production is likely to be above average, nor does its drought resistance appear to be remarkable so far. Its performance will be watched with interest. An obvious disadvantage of Ronpha grass is that it does not produce fertile seed, and cannot be sown in the ordinary way by seed as other pasture grasses are. It must therefore be compared with the other fodder grasses which are grown from stems and roots, such as Elephant grass and Giant *Setaria*, and unless it produces more nutrients per acre than these do, particularly in the dry season, there would not be any advantage in using it. Further investigations on this grass will be carried out in the coming season.

Phalaris daviesii is a hybrid between *P. tuberosa* and *P. minor* which has been produced in Australia, but unlike Ronpha grass, it is able to produce viable seed. Its performance at Kitale indicates that it is worth further trial here, and probably even more so at higher altitudes.

About 30 varieties of Subterranean Clover were tested during the year to see if any could be found which combine good seed-producing qualities with abundant leaf production. Most of the varieties tested are good in one or other respect, but not both. As a result of the work done, and due to generous assistance from research workers in Australia, some further promising varieties will be tried out here which may well combine both these important features. All the available varieties in commercial use, except Dwalganup, need a vernalization period (i.e. a certain amount of cold weather and sometimes frost) before they are able to set seed. Dwalganup is a good seed producer at Kitale, but not as productive as one would wish, and we are therefore looking for a better variety which suits our conditions here. Meanwhile, however, Dwalganup is a variety which can be used by farmers, provided it is supplied with the right inoculant and also with superphosphate.

Progeny Testing and Studies on Flowering in Grasses

PROGENY TESTS

A study of the progeny of Molasses grass and *Cenchrus ciliaris* (African Foxtail) was begun in 1954. Four varieties of Molasses grass and six varieties

of *Cenchrus* were grown for three generations in adjacent plots so that they could easily cross-pollinate. However, the first and second generations (F1 and F2) remained quite uniform and true to type. These results suggest that the varieties of these two species do not mix easily and are either self-pollinating, or apomixis is a prevailing method of seed production. As nothing much seems to be known about the reproduction of these grasses the results obtained are of importance for seed production and the building up of improved strains. Similar work with Rhodes grass started in 1956, and first results indicate that varieties of Rhodes grass mix easily, thus suggesting cross-pollination. More observations are needed to form definite conclusions regarding the type of reproduction in these grasses.

A STUDY OF THE FLOWERING OF SOME KENYA GRASSES

The mechanism of flowering in Signal grass (*Brachiaria brizantha*) and in Rhodes grass was studied between April and June. The order of appearance of the male and female parts of the floret, the hours of flowering, and the time required for seed ripening and other details were observed. In Rhodes grass, for instance, flowering takes place early in the afternoon. Cloudy dull weather may hold up flowering until 4 or 5 o'clock, while on bright sunny days the florets open soon after 1 p.m. Flowering begins in the middle part of the raceme and spreads to both ends, and although flowering continues for about a week, over 80 per cent of the florets flower in the first two-three days. The florets open almost simultaneously in all flowering spikelets, racemes, panicles and plants, and even different varieties flower at the same time. The flowering, the opening of the floret, exposure of anthers and stigmas and bursting of the anthers takes only a very short time and is completed in about 15-25 minutes. About 25 days elapse between the beginning of flowering until the seed ripens. The study of flowering was undertaken with a view to obtaining a better understanding of the process of reproduction, and for future use in plant breeding technique.

PRELIMINARY GRAZING TRIALS

The next stage after nursery work is the testing of the more promising species in a small scale rotation of seven acres under grazing in the field. Varieties of Rhodes grass, Molasses grass and Star grass have been dealt with in this way, and also four species of *Paspalum*, as well as Nandi *Setaria* and *Beckeropsis unisetata*. *Paspalum paniculatum* and *B. unisetata* showed up well in these trials, and will now go into the larger scale grazing trials, the former being about the best of the *Paspalum* species under trial.

The best legumes in these trials were Kenya White clover, Louisiana White clover, Subterranean clover and *Desmodium uncinatum*. With *Trifolium rueppellianum*, three varieties out of four showed so much vigour that they suppressed the grass. *T. usambarense* also tended to be too strong for the grass. Kenya White and Louisiana White clover are both palatable and set plenty of seed, and the Dwalganup variety of Subterranean clover is the best seed producer of those varieties so far tested. *Desmodium uncinatum* should be useful in places with a hotter or wetter climate than Kitale, though its performance here seems fairly satisfactory up to date.

There seem to be a number of suitable legumes for use under Kitale conditions, and the next stage is to compare them from the point of view of (a) increasing the production from mixtures in which they are included, (b) their effect on beef and milk production, and (c) their influence on soil fertility. It is suggested that the two perennial white clovers should be tried on fertile soils with good rainfall, and the annual species such as Rueppells clover, Usambara clover and Subterranean clover should be tried on less fertile soils or on those with lower or less reliable rainfall.

SPECIES AND MIXTURES FOR LEYS

The herbage agronomy work has been concerned mainly with the following species, generally used in the form of grass-legume mixtures :—

GRASSES—

<i>Chloris gayana</i>	—Rhodes grass	} General purpose leys.
<i>Cynodon dactylon</i>	—Common Star grass	
<i>Melinis minutiflora</i>	—Molasses grass	
<i>Setaria sphacelata</i>	—Nandi <i>Setaria</i>	
<i>Beckeropsis unisetata</i>	—Beck grass	} Dry season leys.
<i>Panicum maximum</i>	—Guinea grass	
<i>Pennisetum purpureum</i>	—Elephant grass	

LEGUMES—

<i>Medicago sativa</i>	—Lucerne	} General purpose leys.
<i>Trifolium repens</i>	—Louisiana White clover	
<i>Trifolium rueppellianum</i>	—Rueppells clover	
<i>Trifolium semipilosum</i>	—Kenya White clover	
<i>Trifolium subterraneum</i>	—Subterranean clover	} Dry season leys.
<i>Glycine javanica</i>	—“Glycine”	
<i>Dolichos</i> sp. nr. <i>lablab</i>	—“Kitale Vine”	

The more critical experiments at Kitale will be concerned primarily with these in the coming season.

AN EVALUATION OF GRASS-LEGUME MIXTURES

An exploratory trial, established in 1955 for the purpose of studying the effect of legumes on herbage production in grazing mixtures, is now beginning to give interesting results. The trial includes four grasses, namely Star, Molasses, Nandi *Setaria* and Nzoia Rhodes. Each of these is planted in three different arrangements, consisting of grass alone, grass with Kenya White clover, and grass with clover and lucerne. Each of these mixtures was established with three different level of phosphate; P1 with 2 cwt. double superphosphate per acre in 1955 and again 1 cwt. in 1956; P2 with 4 cwt. in 1955 only; and PO, the control, with no phosphate. The results from the four sets of grass treatments have been taken together, and the following pairs of factors examined statistically:—

MEAN YIELD OF DRY MATTER—1955

(Tons per acre)

TREATMENT	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Grass	2.65	0.53	0.21	P=0.05
Grass and Clover	2.12			
Grass	2.65	0.75	0.20	P=0.01
Grass, Clover and Lucerne	1.90			

MEAN YIELD OF CRUDE PROTEIN—1955

(lb. per acre)

TREATMENT	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Grass	542	31	12.6	N.S.
Grass and Clover	511			
Grass	542	56	26.3	N.S.
Grass, Clover and Lucerne	486			

Comments.—During the establishment year the mixing of legumes with the grass caused a general decrease in both dry matter and protein yields. Nevertheless, the latter was not significant.

MEAN YIELDS OF DRY MATTER—1956

(Up to November—Tons per acre)

TREATMENT	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Grass	1.404	0.003	0.06	N.S.
Grass and Clover	1.401			

MEAN YIELD OF CRUDE PROTEIN—1956

(Up to November—lb. per acre)

TREATMENT	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Grass	159	69	16.9	P=0.01
Grass and Clover	228			
Grass	159	80	18.2	P=0.01
Grass, Clover and Lucerne	239			

Comments.—So far during 1956 there has been no apparent decrease in the yield of dry matter, but there has been a significant increase in the yield of crude protein as a result of mixing legumes with the grasses.

The following table illustrates the trend of crude protein contained in the grass alone, as compared with grass-clover mixtures. The effect of the legume in maintaining protein during the second season is of particular interest.

MEAN CRUDE PROTEIN CONTENT OF FOUR GRASSES UNDER GRAZING
(Per cent of dry matter)

DATE GRAZED	1955			1956			
	19/7	29/8	18/11	14/2	9/5	24/7	21/9
Grass	19.71	9.91	9.00	4.80	6.76	7.36	6.34
Grass and Clover	22.11	11.13	8.88	5.40	9.31	11.31	12.08

A suggestion has sometimes been made that in parts of East Africa there is little or no justification for the inclusion of legumes in grazing leys, as the grass alone is said to contain sufficient protein for a satisfactory level of milk production throughout the season. This view is not supported by the last three samples for 1956, which illustrate the value of clover for maintaining protein after the first year.

THE EFFECT OF DIFFERENT ROW SPACINGS ON THE YIELD OF LUCERNE

Hunter River Lucerne, established in pure stand in 1954, has given the following yields to date:—

YIELD OF GREEN MATERIAL
(Tons per acre)

SEASON	SPACING				S.E. of Mean Difference
	1 ft.	2 ft.	3 ft.	4 ft.	
1954	8.59	7.47	7.70	6.62	0.51
1955	10.47	11.32	13.13	13.11	0.70
1956*	6.05	6.15	5.92	5.93	0.68

*Up to November.

YIELD OF CRUDE PROTEIN
(lb. per acre)

SEASON	SPACING				S.E. of Mean Difference
	1 ft.	2 ft.	3 ft.	4 ft.	
1955	1,204	1,249	1,522	1,473	99
1956*	682	719	680	680	67

*Up to November.

While close spacing gave the highest yield in the establishment year, the 3-ft. and 4-ft. spacings were superior in the following season. Based on results so far obtained, a 3-4-ft. spacing seems advisable for non-irrigated lucerne under these conditions as wider rows are easier to handle and cultivate. From the point of view of yield, there is little to choose between the different spacings over a period of time.

A COMPARISON BETWEEN LUCERNE AND RUSSIAN COMFREY

It was decided to examine the performance of Russian Comfrey at Kitale. A trial was therefore laid down in 1955, to compare it with lucerne as regards production. Both were established in pure stand, with and without fertilizers, and under exactly comparable conditions. The following results have been obtained to date:—

YIELD OF DRY MATTER
(Tons per acre)

SEASON	LUCERNE		COMFREY	
	Control	With fertilizer	Control	With fertilizer
1955	1.72	2.18	1.72	1.89
1956*	1.38	1.90	1.44	1.33

*Up to November.

The fertilized plots have received $1\frac{1}{2}$ cwt. of double superphosphate and 5 tons of farmyard manure per acre annually. The yield differences are not significant, although the fertilized lucerne has given slightly higher yields in both seasons.

Single samples taken in mid-August during each season have given the following analysis on a dry matter basis:—

COMPOSITION OF THE HERBAGE
(Per cent of dry matter)

SEASON	Species	Ash	Crude Protein	Crude Fibre	P	Ca
1955 ..	Lucerne ..	10.36	30.52	27.76	0.29	1.43
	Comfrey ..	19.73	23.38	9.90	0.34	1.35
1956 ..	Lucerne ..	9.59	20.17	19.90	0.33	0.96
	Comfrey ..	22.05	17.31	12.61	0.47	1.56

The digestibility of the lucerne protein is substantially higher than that of the comfrey, as shown by the following analysis from the first cut in 1955:—

DIGESTIBILITY OF THE CRUDE PROTEIN
(Per cent of dry matter)

SPECIES	Crude Protein	Digestible Crude Protein	Per cent Digestibility of Crude Protein
Lucerne	30.52	28.16	92.27
Comfrey	23.38	12.45	53.25

Results so far may be summarized by saying that under these conditions, lucerne appears to be superior to comfrey in respect of its crude protein content but not in its fibre content. Comfrey may, however, have a special place in the feeding of pigs and poultry, where low fibre feeds are preferable.

WHITE CLOVERS

Work has continued on the comparison of different strains of Kenya White clover. The two best so far are the Kabete variety, which is in use on the station already, and that from Ol Joro Orok. Another good strain of European White clover has come to light. The seed of this clover was obtained from Bamenda in the Cameroons, where it has been growing wild for some years, though it has not been possible to ascertain its exact origin so far. It seems to be at least as good as Louisiana White clover, and further experimental work to compare the various white clovers is now necessary. Ladino clover is also undergoing field trials.

LUCERNE

The lucerne variety trial, though not yet complete, still confirms previous indications that the best varieties of those under test seem to be Saladina, Pampeana, Smooth Peruvian, Hairy Peruvian, all ex South America, and a variety of *Medicago falcata* from the U.S.A. The varieties Caliverde and Buffalo, mentioned last year, seem to be rather less productive than those mentioned above. All these varieties appear to be better than Provence and Hunter River which are in common use in Kenya at present.

MANAGEMENT OF LEYS

The Management of General-purpose Grazing Leys.—In 1955 a trial was undertaken to observe the effects of four management treatments on four different mixtures containing grass, clover and lucerne. Overall fertilizer dressings were applied at the rate of 2 cwt. double superphosphate plus 1 cwt. sulphate of ammonia in 1955, and $\frac{1}{2}$ cwt. double superphosphate plus 1 cwt. sulphate of ammonia in 1956. The following results have been obtained so far:—

EFFECT OF MANAGEMENT ON GRAZING FREQUENCY AND INTENSITY

MANAGEMENT	No. of grazings	Cow grazing days per acre	No. of grazings	Cow grazing days per acre
	1955		1956*	
(1) Grazing tall herbage without mowing	4	264	5	248
(2) As in (1) but mowing the residue after each grazing	3	156	4	173
(3) Cutting the first flush for hay followed by grazing as in (1) ..	Hay and 3	170	Hay and 4	180
(4) Frequent grazings at a young stage, with residues mown ..	5	186	6	181

*Up to December.

Hay yields taken from the first flush in Management No. 3 were as follows:—

YIELD OF HAY
(Cwt. per acre)

SEASON	Rhodes, Lucerne and Clover	Molasses, Lucerne and Clover	Nandi <i>Setaria</i> , Lucerne and Clover	Slender Guinea, Lucerne and Clover
1955	11.1	11.1	17.6	13.3
1956	15.5	22.2	15.5	15.5

The effects of management so far may be summarized by saying that treatments Nos. 1 and 3, with lenient grazing of tall herbage, have clearly given the best results. The frequent grazing and mowing of treatment No. 4 has resulted in a strong dominance of Kenya White clover at the expense of the grass and lucerne; while the other treatments are maintaining a satisfactory balance between the three components. Treatment No. 4 would obviously be of value in the last year of the ley before ploughing in, to obtain nitrogen-rich material for ploughing in.

EFFECT OF FERTILIZERS AND MANURES

The Effect of Fertilizers on Elephant Grass

A 2⁵ experiment was established in 1954 to examine the effects of fertilizers and green manure on the growth of elephant grass. The rates of application have been:—

N=2 cwt. per acre of ammonium sulphate after each cut.

P=1½ cwt. per acre of double superphosphate annually at the start of the season.

K=2 cwt. per acre of muriate of potash annually at the start of the season.

L=2½ tons per acre of agricultural lime once before the start of the experiment.

G=Bitter Lupin or *Trifolium rueppellianum* grown in between the grass rows and dug in at the end of each season.

Results to date show that superphosphate alone was important during the establishment year, but both N and P in the second year. Subsequently N has been the only factor of importance.

Significant effects are shown in the following table:—

YIELD OF DRY MATTER
(Tons per acre)

SEASON	Mean Yield	Effect of N.	Effect of P.	S.E. of the Mean
1954	2.05	—	2.59	0.15
1955	5.03	6.48	5.60	0.18
1956*	3.83	5.89	—	0.32

*Up to October.

There have been no significant interactions so far.

The Effect of Gypsum on Lucerne, Russian Comfrey, White Clover and Grass

Pot tests carried out by Dr. E. M. Chenery of Kawanda Research Station, Uganda, indicated an appreciable sulphur deficiency in the soils on the Kitale Grassland Station. Accordingly, split plot dressings of gypsum at $1\frac{1}{2}$ cwt. per acre were applied to three experiments towards the end of 1956. These experiments have each been mentioned earlier in the section headed Species and Mixtures for leys, and are as follows:—

(i) *An Evaluation of Grass-Legume Mixtures.*—The following table shows the effect of gypsum three months after its application, on the yield of grass by itself, and on a mixture of grass with legumes. This is from a single cut:—

MEAN YIELDS OF DRY MATTER
(Tons per acre)

TREATMENTS	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Grass without Gypsum ..	0.38	0.05	0.018	P=0.05
Grass with Gypsum ..	0.33			
Grass and Legumes without Gypsum	0.37	0.09	0.023	P=0.02
Grass and Legumes with Gypsum	0.46			

Comments.—At the first harvest gypsum caused a significant decrease in the dry matter yield from grass alone, but, by way of contrast, a significant increase was obtained from the grass-legume mixtures.

In the following table, yields from grass alone are compared with those from grass-clover mixtures, in the presence and absence of gypsum. These are from a single cut three months after application of the gypsum:—

MEAN YIELD OF DRY MATTER
(Tons per acre)

TREATMENT	Without Gypsum	With Gypsum
Grass	0.38	0.33
Grass and Clover	0.37	0.46
Mean Difference	0.01	0.13
S.E. of Mean Difference	0.035	0.045
Level of Significance	NS.	P=0.02

Comments.—In the absence of gypsum, the addition of clover to the grass made no appreciable difference to the dry matter yields. In the presence of gypsum, the addition of clover to the grass caused a significant increase in the dry matter yield.

In the following table the effect of phosphate (at the P1 level) on yields of grass-legume mixtures is compared in the presence and absence of gypsum:—

MEAN YIELDS OF DRY MATTER
(Tons per acre)

TREATMENT	Without Gypsum	With Gypsum
Grass-legume mixtures (without P)	0.33	0.35
Grass-legume mixtures (with P)	0.42	0.53
Mean Difference	0.09	0.18
S.E. of Mean Difference	0.033	0.044
Level of Significance	P=0.05	P=0.01

Comments.—Phosphate at the P1 level brought about a significant yield increase in both comparisons, but the increase was greater when in the presence of gypsum.

(ii) *The Effect of Different Row Spacings on the Growth of Lucerne.*—The following table shows the effect of gypsum on a pure stand of non-irrigated lucerne. The figures are from the first two harvests after an application of $1\frac{1}{2}$ cwt. per acre.

MEAN YIELDS OF DRY MATTER
(Tons per acre)

TREATMENT	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Lucerne without Gypsum ..	0.51	0.23	0.04	P=0.001
Lucerne with Gypsum ..	0.75			

This effect is unlikely to be due to the lime content of the gypsum, as an overall dressing of $2\frac{1}{2}$ tons of agricultural lime per acre was applied in 1954 at the start of the experiment.

(iii) *A Comparison between Lucerne and Russian Comfrey.*—The following table shows the effect of gypsum on pure stands of lucerne and Russian comfrey. The figures are from the first cut after an application of $1\frac{1}{2}$ cwt. per acre.

MEAN YIELDS OF DRY MATTER
(Tons per acre)

TREATMENTS	Mean Yield	Mean Difference	S.E. of Mean Difference	Level of Significance
Lucerne without Gypsum ..	0.27	0.11	0.02	P=0.01
Lucerne with Gypsum ..	0.38			
Comfrey without Gypsum	0.23	0.03	0.01	P=0.05
Comfrey with Gypsum	0.26			

Comments on trials (ii) and (iii) above.—In each of these comparisons the application of sulphur in the form of gypsum has resulted in a significant increase in yield.

(iv) *The Effect of Phosphate and Inoculant on Lucerne.*—The 16 plots of this experiment were split for the application of gypsum on one half at the rate of $1\frac{1}{2}$ cwt. to the acre, towards the end of the rains. The "t" test showed that the increased yields obtained after gypsum application were significant.

A significant increase in yield has thus been obtained as a result of adding gypsum in three experiments with lucerne and one with Russian comfrey. The effect of gypsum has also shown up very strongly on plots containing Kenya White clover, in which the clover changed from yellowish green to a darker green, and grew more vigorously.

THE EFFECT OF FERTILIZERS ON NATURAL GRASSLAND

A 3³ factorial experiment was carried out to ascertain the effect of 0, 1 cwt. and 2 cwt. per acre of sulphate of ammonia, double superphosphate, and common salt, singly and in all combinations, on the production of natural grassland. The experiment is not yet concluded, but the trend of results to date shows that yields are increased substantially by sulphate of ammonia, less so by double superphosphate, and slightly depressed by the addition of common salt. The latter treatment was tried out, as some soil analyses have indicated a somewhat low level of sodium and of chlorine in the soil. Nevertheless the addition of sodium chloride seems to serve no useful purpose so far.

LEGUME EXPERIMENTS

The work on legumes was continued during the year to ascertain the response to the application of phosphate and inoculant of the more promising pasture and fodder legumes which are now available. The object is to ensure that in the presence of phosphate and inoculant, the yield per acre, and also the nitrogen content of the plants, is increased. Any increase brought about by inoculation with nitrogen fixing bacteria is presumably due to the fixation of nitrogen by these bacteria. In the case of cultures supplied by the Senior Plant Pathologist, they are ones which have been tested under laboratory conditions, to make certain that they are efficient strains.

Five legumes were used, and the species, treatment combinations, yields of dry matter, protein and phosphate per acre are shown in the table below:—

	IN P	IN -P	-IN P	-IN -P	Mean	S.E. of the Mean
Sub. Clover (cwt./acre D.M.)	43.75	34.75	32.00	29.50	35.00	0.88
C. Protein cwt./acre ..	5.05	4.32	2.79	2.75	3.72	
P. lb./acre	11.20	6.72	8.96	6.72	6.72	
Louisiana White Clover (cwt./acre D.M.) ..	26.80	15.70	11.70	8.30	15.60	2.06
C. Protein cwt./acre ..	4.27	2.78	1.64	1.17	2.46	
P. lb./acre	6.72	4.48	3.36	2.24	4.20	
<i>Trifolium rueppellianum</i> (cwt./acre D.M.) ..	51.00	32.00	30.00	19.00	33.33	2.70
C. Protein cwt./acre ..	19.86	19.56	14.69	11.35	16.30	
P. lb./acre	10.85	6.45	9.74	4.25	7.82	
Sweet Lupins (cwt./acre D.M.)	81.00	57.00	63.00	42.00	61.00	3.80
C. Protein cwt./acre ..	8.97	7.94	6.91	5.00	7.20	
P. lb./acre	16.80	10.08	7.84	10.64	11.34	
Lucerne (cwt./acre D.M.)	35.75	28.25	23.75	24.75	28.13	2.30
C. Protein (cwt./acre) ..	6.72	5.90	4.74	5.56	5.73	
P. lb./acre	15.21	10.76	10.56	10.81	11.59	

The rate of application of the double superphosphate was 1 cwt./acre. All plants were sown in drills 1 ft. apart and thinned to 6 in. apart in the rows, except Lupins which were spaced 12 in. apart.

Each of the five experiments gave significant results, and the effect of using both phosphate and inoculant was significantly better than any of the other treatments in each experiment.

A comparison of the yields obtained from the treatments receiving no phosphate or inoculant shows that in some cases they are markedly poor by comparison.

The results from Subterranean clover and lucerne show less contrast than the others. Lack of treatment with gypsum to correct the sulphur deficiency, as already mentioned in the preceding section on Effect of Fertilizers and Manures, may very likely account for this, and the question will be investigated next season.

ANIMAL AGRONOMY

The function of the animal agronomist is to compare the value of different species or mixtures, or of different methods of grassland management, by the amount of meat or milk which they produce.

The foundations of the herd have now been laid, as a further 60 Boran cows have recently been bought in addition to the 39 acquired just over a year ago. A herd of Boran steers has also been bought. The animal agronomy work will be carried out with the progeny of a Red Poll bull on Boran cows. A collection of twins is also being built up for use in comparing production from different swards and managements.

Meanwhile a number of observations and preliminary experiments have been carried out with the present available cattle.

THE EFFECT OF MATURE NATURAL GRASSLAND ON THE WEIGHT OF STEERS

Twenty-eight Watende, three Aberdeen-Angus x Boran and eight Red Poll steers were put in a 40-acre paddock of natural grassland in mid-October after three weeks pre-weighings had been obtained. The grass was very mature and chiefly stem, and the protein content was 2.66 per cent at the start and 2.76 per cent at the finish in the paddocks. Evidence was obtained, as expected, of the inability of such grazing to maintain young growing cattle. Results are shown in the table below.

No. of Cattle	Type	21 DAYS ON SHORT GRAZED VELDT (<i>Hyparrhenia filipendula</i> and <i>Loudetia kagarensis</i>)			
		Lb. Start	Lb. Gain	Lb. per Day	Lb. at Finish
28*	.. Watende ..	388	+18	+0.86	406
3	A/Angus	300	+15½	+0.74	315½
8	x Boran	583	+25	+1.19	608
	Red Poll ..				

No. of Cattle	Type	NATURAL GRASSLAND PADDOCKS (<i>Hyparrhenia filipendula</i> and <i>Loudetia kagarensis</i> (VERY MATURE)					
		First 35 days			Next 21 days		
		Lb. Gain	Lb. per Day	Lb. at Finish	Lb. Loss	Lb. per Day	Lb. at Finish
28*	Watende ..	+10	+0.29	416	-21	-1.00	395
3 ..	A/Angus						
	x Boran	+18½	+0.53	334	-9½†	-0.68	324½
8 ..	Red Poll ..	+23	+0.66	631	-42‡	-2.00	589

*Sixteen in herd only in last seven days, but at 14 days loss was also 1.00 lb. per day.

†Fourteen days only.

‡Five in herd only in last seven days, but at 14 days loss was also 2.20 lb. per day.

Grazing behaviour observations were made in March, April, May, June, September and December, to determine:—

- (1) The general pattern of grazing in a highland sub-tropical climate. (Results are shown in Table below.)
- (2) The differences in behaviour between *Bos taurus* and *Bos indicus*, if any. (No significant differences were found during the typical weather experienced here from April to September when mornings were hot, but afternoons cloudy and generally cool. The dry season may produce differences, if the December results are confirmed, and these are, briefly, some 30 minutes more grazing at night by Grades, whose total grazing time was also 30 and 50 minutes longer than the Borans with which they were compared.)

GRAZING BEHAVIOUR OF BORAN CATTLE WITHIN A COMMONLY PRACTISED KENYA ROUTINE IN A SUB-TROPICAL CLIMATE AT AN ALTITUDE OF 6,200 FT.

15 OBSERVATIONS WITH 9 HEAD MAY TO SEPTEMBER	Between a.m. & p.m. Milking	P.M. Milking to Dusk	Night	Dawn to a.m. Milking	Total
Hours grazing	4.94	1.25	1.34	0.07	7.60
Hours available for grazing	6.97	2.19	10.75	0.68	20.59
Grazing time as a per- centage of time avail- able per period ..	70.88%	57.08%	12.47%	10.29%	36.22%
Grazing time as a per- centage of total grazing time	65.00%	16.45%	17.64%	0.01%	100.00%

SEED MULTIPLICATION AND SEED CERTIFICATION

Seed Multiplication

Apart from some 60 grasses and legumes being multiplied for experimental purposes, three species are now being grown on a field scale at Kitale for seed multiplication. They are Kenya White clover (*Trifolium semipilosum*), Slender

Guinea grass (*Panicum maximum* var. *trichoglume*) and Nandi *Setaria*. In addition, one acre each of Molasses grass and Nzoia Rhodes grass were grown so as to supply sufficient seed for the station.

Slender Guinea Grass

In recent years there has been an improvement in the seeding characteristics of this grass. It responds well to high fertility, and seed yields of 200 lb. per acre at a single harvest can be obtained under field conditions. Seed yield, however, appears to be severely reduced under conditions of low fertility, or if the first flush of growth is removed by mowing or grazing.

During 1956 $2\frac{1}{2}$ acres of this grass were planted for seed at Kitale. To date 250 lb. of seed have been harvested and another 100 lb. is expected. Although all seed of this species has so far been hand harvested, it should be easily handled by the combine harvester.

Nandi Setaria and Seed Certification

During 1956 a pilot scheme for the production of certified herbage seeds was launched, using the grass Nandi *Setaria*. Under the scheme, the Grassland Research Station produces what is termed Foundation Seed. This, when planted out, produces Mother Seed, and this in turn gives rise to Certified Seed. This year both Foundation and Mother Seed have been produced by the Grassland Station, but it is hoped that Mother Seed production will be taken over by selected farmers. The first Mother Seed was issued to co-operating farmers in 1956, but it is not expected that Certified Seed will be available for sale until later in 1957.

At the Grassland Research Station, Kitale, in 1956, nine acres of Nandi *Setaria* planted in 1953-54 for Foundation and Mother Seed production were maintained, and a further four acres were planted. At the neighbouring Kitale Prison Farm another 14 acres for Mother Seed were planted, and in spite of severe weed competition in the early stages, over 700 lb. of seed has been collected from this source.

Unfortunately a disease (bunt), which had not previously been troublesome, became widespread throughout the Trans Nzoia and Uasin Gishu districts during the year, and it has caused considerable losses. Its control is receiving attention from the Senior Plant Pathologist.

Report of the Pasture Research Chemist

THE CRUDE FIBRE ESTIMATION

The "Weende" procedure for determining crude fibre in feeding stuffs, as modified and incorporated into the British Fertilizers and Feeding Stuff Regulations, 1932, is said to be adequate to meet the requirements of materials usually examined in relation to those regulations, but a more detailed specification of procedure is required for examining materials in a fine state of subdivision and of low fibre content. Work carried out in this laboratory, using seven kinds of plant materials, including fodders, faeces and concentrates, and six different filter media for removing the acid digest, show that—

- (i) for fodders and faeces, there is no significant difference between the resulting crude fibre values when a Whatman No. 54 filter paper, a standard U.S. filter cloth and a long-staple terylene cloth is used, but that for these same materials the values obtained with linen are significantly lower than those obtained with the other five filter media;
- (ii) two other terylene cloths give significantly lower values than those obtained by using the No. 54 filter paper;

- (iii) for concentrates, viz. earthnut cake and cassava meal, which are both very low in crude fibre and the latter is, in addition, in a very fine state of subdivision, filtering through the Whatman No. 54 filter paper gives crude fibre values that are significantly higher than those obtained by filtering the acid digest through any of the five different filter cloths. This work suggests that filtering the acid digest through cloth is permissible for fodders and faeces provided that the retentiveness of the cloth does not differ significantly from that of filter paper, but that filtering through cloth is not permissible for concentrates or materials of low fibre content and/or in a fine state of subdivision. For these materials it is agreed that a more detailed specification of the procedure for the determination of crude fibre is desirable if concordant results are to be achieved.

AN "ACID" CRUDE FIBRE DETERMINATION

Results obtained in this laboratory show that when Rhodes grass hay and Kikuyu grass hay, and the faeces obtained as a result of feeding these foodstuffs to sheep, are digested with increasing concentrations of sulphuric acid for increasing intervals of time, there is a direct and inverse relationship between a resulting "crude fibre" fraction and (i) the logarithm of the concentration of the acid to 6 N, which was the maximum concentration used, and (ii) the logarithm of the time of digestion to 2 hr., which was the maximum time allowed for digestion. Results obtained by digesting *Setaria splendida*, *Symphytum peregrinum* and *Trifolium semipilosum* with 7.5 per cent sulphuric acid at $\frac{1}{2}$ hr. intervals to 3 hr. show that there is a direct and inverse relationship between the resulting "crude fibre" fraction and the logarithm of the time allowed for digestion. It would appear that at this altitude (6,200 ft.) a digestion with either N. or 5 per cent H_2SO_4 or 1.5 N. or 7.5 per cent H_2SO_4 for $1\frac{1}{2}$ hr. should be adequate for an acid "crude fibre" determination, since the difference between the crude fibre residue resulting from a digestion with N. or with 5 per cent H_2SO_4 and from a digestion with 1.5 N. or 7.5 per cent H_2SO_4 , if expressed as a percentage of the N. or of the 5 per cent H_2SO_4 value, does not exceed 4.7 per cent. It so happens that a digestion of 1 hr. duration with 5 per cent H_2SO_4 is the pre-treatment used by Norman in his method for the determination of lignin. It is therefore likely that a digestion with N. or 5 per cent H_2SO_4 will be favoured for an acid crude fibre determination, since that of lignin, by Norman's method, could follow if required.

DIGESTIBILITY STUDIES

Studies on the Wedemeyer "in vitro" determination of the digestibility of the crude protein contained in animal foodstuffs have been made over a wide range of herbage materials and plant products, including silages, fodder plants and fodder trees. A direct relationship has been found between the crude protein content of a plant foodstuff and its content of digestible crude protein. This relationship can be expressed by the equation:—

$$\text{Digestible Crude Protein} = 0.939 \text{ Crude Protein} - 2.51. \quad \text{Equation 1.}$$

The relationship between crude protein and percentage digestibility of crude protein can be expressed by the following equation:—

$$\text{Per cent digestibility of crude protein} = 41.228 \log. \text{ Crude Protein} + 25.49. \quad \text{Equation 2.}$$

For the same materials crude fibre is related to crude protein, and the following equation expresses this relationship:—

$$\text{Crude fibre} = 41.99 - 19.36 \log. \text{ Crude Protein.} \quad \text{Equation 3.}$$

FIELD EXPERIMENTS

On the E.A.A.F.R.O. Farm at Muguga a Star grass experiment was established in 1953. Three levels of sulphate of ammonia (0, 0.75 and 1.5 cwt. per acre), three levels of triple superphosphate (0, 0.75, and 1.5 cwt. per acre) and three levels of one treatment (0, 5 cwt. common salt, 3 cwt. sulphate of potash per acre) were given to establish the grass from splits planted at 2 ft. x 2 ft. spacings. Sulphate of ammonia and superphosphate were applied again at the beginning of the growing season in 1954 and 1955. The data given below show the effect of the phosphatic fertilizer, in the presence of N only, on the total yield of dry matter and of plant nutrients obtained during the period 1953-1956.

ANNUAL APPLICATION OF TRIPLE SUPERPHOSPHATE (CWT. PER ACRE)				TOTAL YIELDS 1953-1956				
				Dry Matter (tons per acre)	N	Ca	P	Cl
	0	..	..	6.0	242	64	31	26
P	0.75	..	..	7.1	290	86	42	33
P	1.50	..	..	8.5	352	96	45	37

The superphosphate gave significant responses in terms of yield of dry matter annually, the sulphate of ammonia gave significant responses only in the wet year of 1954/55. Significant differences between replicates occurred when rainfall was limited, and a phosphate-rainfall interaction of significance was obtained for the season 1955/56. Neither the superphosphate nor the sulphate of ammonia had any significant effect on yield of nutrients during the two dry seasons of 1953/54 and 1955/56, but in the wet season of 1954/55, the application of the phosphatic fertilizer caused a significant increase in the yield of N and of P and, during this same season, the application of the nitrogenous fertilizer caused a significant increase in the yield of Ca. The yield of P was increased significantly in the 1953/54 season by the sulphate of potash applied at the beginning of that season for establishment: the common salt had no similar effect. Yield of Cl showed a significant response in all seasons to the common salt applied in 1953 for establishment. In the third season, 1955/56, yield of Cl was affected significantly by the higher, but not by the lower rate of application of sulphate of ammonia.

The effect of the annual applications of the superphosphate applied to the grass was tested in a crop of swedes, planted in April, 1956, after the grass had been ploughed under. These effects of P, in the presence of N, are summarized below:—

SWEDE TOPS								
TRIPLE SUPERPHOSPHATE (CWT. PER ACRE)				Yield of Dry Matter (lb./acre)	Per cent P in Dry Matter	Yield (lb. per acre)		
						N	P	Ca
P	0	..	..	276	0.15	6.0	0.41	7.7
P	0.75	..	..	429	0.18	8.2	0.76	11.4
P	1.50	..	..	403	0.18	9.3	0.76	11.4

TRIPLE SUPERPHOSPHATE (CWT. PER ACRE)	SWEDE ROOTS				
	Yield of dry Matter (lb./acre)	Per cent P in Dry Matter	Yield (lb. per acre)		
			N	P	Ca
P 0	500	0.10	10.5	0.53	2.3
P 0.75	791	0.14	10.2	1.11	3.3
P 1.50	676	0.15	8.9	0.99	3.2

With the exception of the yield of N from the roots, all other yields have been increased by the phosphate applied to the grass, and the phosphate content of both roots and tops also are enhanced.

FURTHER WORK ON STAR GRASS

Two Star grass experiments were established this year, one on the E.A.A.F.R.O. Farm, Muguga, the other on the Station Farm, Kitale, to study the phosphate requirements of grazed pastures. The Muguga experiment has been profoundly and adversely affected by lack of adequate rainfall and although phosphate responses are clearly apparent visually, no yield data have yet been obtained. In the Kitale experiment yield data obtained on the occasions of the first grazings show that (i) there is no significant difference between the yields of dry matter obtained from plots that received the equivalent of 75 lb. and of 150 lb. of triple superphosphate per acre, each together with the equivalent of 50 lb. urea per acre; and (ii) the yields obtained by these treatments do not differ significantly from those obtained either with a treatment of 50 lb. urea per acre only or of 18 lb. triple superphosphate per acre only. In both these experiments the grass was established from splits, spaced at 2 ft. x 2 ft. intervals at Muguga and 3 ft. x 3 ft. intervals at Kitale. The precise amount of each fertilizer or combination of both fertilizers was placed in the same hole as the splits at the time of planting. After each grazing, urea was applied broadcast to appropriate plots.

Molo Grassland Research Sub-station

Current experiments are in their early stages and interim reports on them, beyond what has already been published, are not warranted. (Annual Report, 1956, Vol. 1, Page 38.)

As the station was stocked up during the year it is now in a position to go ahead with management and longer term experiments than was possible in the past. Results of such experiments will naturally take some time to reach fruition. The results of nodulation observations during the year indicate that Subterranean clover is probably the most promising of the legumes of which seed is available commercially, and much of the work planned for 1957 will be based on this species.

Report of the Pasture Research Officer, Katumani, Machakos

It was originally intended to establish a pasture research station at Makueni but attempts to find a satisfactory site failed as the only possible places suffered from low rainfall, tsetse fly, lack of water and inaccessibility. It was therefore decided to place the headquarters of Pasture Research at Katumani. Owing to the large amount of development needed at Katumani no serious pasture research could be started there in 1956, but an account of some preliminary work follows:—

Nursery Plots.—Plots at Katumani were only established during the Short Rains and have therefore provided little information yet. However observations on legumes showed that the majority will nodulate without using special inoculants though lucerne failed to do this. Both addition of inoculant and phosphate produced striking improvement on small plots of lucerne. At Kampi ya Mawe, the long dry spell, lasting nearly six months when the Long Rains failed, provided a very useful test of drought resistance. The grasses which were most promising were different types of *Panicum*, *Cenchrus ciliaris* and *Setigerus*, *Cynodon dactylon* and *plectostachyon*, *Brachiaria* sp. and different types of Rhodes grass. Among legumes, the only ones which showed promise were *Clitoria ternata* and *Indigofera subulata*. The former was heavily grazed by buck but grew very vigorously when the Short Rains came. The next stage in this side of the work will be to try out the best grasses under grazing.

Fodder Crops.—Both Perennial Kavirondo Sorghum and Sudan grass have been successfully grown and used for silage at Kampi ya Mawe and appear to do well at Katumani. Attempts to find a suitable legume to grow in a mixture with the grass are not promising and it is probably better to grow them separately. Some observations have been made on fodder crops in the hill areas but there is scope for much more work there.

Makavete Grazing Experiments.—During the Short Rains, 1955, half the original experiment was ploughed out and the beans harvested in February, 1956, showed that natural veldt gave the highest bean yields in the absence of former fertilizer applications, while Star grass gave the highest bean yields where fertilizer had been applied in the three previous years. *Panicum makarikari* gave the lowest bean yields with and without residual fertilizer effects. On the grazing plots an attempt was made, based on a previous assessment, to maintain a stocking rate of one beast per two acres. However owing to the failure of the Long Rains it was not possible to take the usual cuts of hay and the animals had to be taken off the plots to prevent damage during July, August, September and October. There is also a decline in productivity on some plots which has lowered the carrying capacity. The Makarikari grass has shown to be very poor under Makavete conditions. Although palatable and productive initially, much of it has died out and the plots have many bare patches which are liable to erosion. Rhodes grass, in spite of some self-seeding, has to a large extent died out leaving patches of weeds and poor grasses. Star grass is better but has not persisted very well. However the mixture of *Eragrostis superba* and *Cenchrus ciliaris* has persisted very well and is providing excellent grazing and a good cover. More persistent strains of Rhodes and Star grass may be found and there seems to be considerable scope for selecting improved strains of *Cenchrus* and *Eragrostis superba*.

The area ploughed up to test the after effects of the leys failed to produce a crop in the Long Rains. The Short Rains' crop of sorghum, maize and beans has done well and has shown very striking effects of previous fertilizer application.

Bush Control.—Bush control experiments using arboricides started in March, 1955, and went on during 1956. Some of the original techniques were shown to be unsatisfactory but improved methods of conducting these trials should give more conclusive results. So far there can be no definite recommendations.

Report of the Pasture Research Officer, Baringo District

The Pasture Research Officer moved into a house at Marigat on 5th October, 1956, and the following work was completed between then and the end of the year:—

Surveys of Land Condition and Potential.—A survey of the Perkerra Catchment Area, to provide information on which a division of the area into grazing blocks could be based, was completed in October. The survey covered about 500 square miles and a map of the area was produced showing the distribution of the land within six classes based on its condition and potential. Similar surveys were completed of the Emining Triangle (Smallholding Area) and the area east of the Molo River.

Other Work.—A start was made on an ecological map of the Baringo district. Transects were demarcated in the Esageri grazing scheme to study the changes occurring in the botanical composition of the herbage. Plans were prepared for the development of the Baringo Pasture Research Station and its future programme of experimental work.

Publications

(1) Bogdan, A. B., The Indigenous Clovers of Kenya. *E.A.A.J.*, Vol. XXII, No. 1, July, 1956.

(2) Bumpus, E. D., Grassland Research: A Review of the Work Carried out at the Grassland Research Station, Kitale. *The Kenya Farmer*, September, 1956.

(3) Dougall, H. W., Crude Fibre: Its Determination and its Place in the Analysis of Animal Feeding-stuffs. *E.A.A.J.*, Vol. XXI, No. 4, 1956.

(4) Strange, L. R. N., Mechanical Appliances for Ley Establishment. *J.R.A.S.K.*, No. 9, February, 1956.

(5) Strange, L. R. N., Perennial Dry Season Leys for Mixed Farming Areas at Medium Altitudes. *The Kenya Farmer*, November, 1956.

E. D. BUMPUS,
Senior Pasture Research Officer.

ANNUAL REPORT OF THE SENIOR HORTICULTURAL OFFICER, 1956

Introduction

The year was marked by considerable development of the horticultural industry in many of its aspects. The formation of the Horticultural Products Committee on which are represented members of the processing industry, the Horticultural Co-operative Union, the Kenya National Farmers' Union, and officers of the field and research services of the Ministry of Agriculture, is already resulting in better organization of the industry through improved liaison.

A review of the horticultural industry and horticultural research entitled "Horticulture", by the Senior Horticultural Officer, was published in *The Kenya Farmer*, September and November, 1956 issues.

The report on the year's work of the Horticultural Section of the Ministry of Agriculture, which follows, is divided into sections for the class of crop, e.g. vegetables, and sub-sections for the individual kinds, e.g. asparagus. The numbers in brackets at the end of individual reports indicate the officer responsible for the work described, and the names and addresses of the officers concerned are given at the end of the report.

Tree Fruits

The latest recommendations for culture of deciduous tree fruits have been included in the chapter, "The Home Orchard", which has been re-written for the new edition of *Gardening in East Africa*.

APPLES

It now seems that the spacing of 20'×20' originally recommended for apples is not likely to give an economic return with most varieties. A spacing of 10'×20' or even 10'×10' is recommended for new plantings; at the latter spacing some thinning of the trees may be necessary at 10 to 15 years after planting. The closer spacings are expected to give a considerably increased return per acre, not only because there are more trees to carry the crop but also because the trees being closer together will provide better protection against wind damage and physiological cracking of the fruit, [1], [2].

The beneficial effect of windbreaks in a young apple orchard has been demonstrated clearly at Molo. Windbreaks of Tree Lucerne were established in a young apple orchard, at a spacing of 100' apart. In April, 1956 the windbreaks had attained a height of 10'-12' and, in order to determine their effect, measurements were made of the amount of vegetative growth made by 64 Jonathan apple trees, with the following results:—

Total vegetative growth of 32 trees on windward side of windbreak, 21'.

Total vegetative growth of 32 trees on leeward side of windbreak, 208'.

The trees on the protected side of the windbreak made almost 10 times as much growth as those on the exposed side and it became obvious that the spacing between windbreaks should be reduced. Spacing has now been reduced to 50' and further observations will be made when the new windbreaks mature, [1], [2], [3].

The use of plastic tape for tying apple grafts has proved greatly superior to the old method of raffia and grafting wax. Plastic tape is quicker and cleaner to use and if properly wrapped produces a satisfactory moisture seal. The union between scion and rootstock is much smoother and constriction at the union is far less than with raffia. The end of the tape should be heat sealed, this is much more satisfactory than tying it, [1], [3].

The following are notes on individual apple varieties:—

Gravenstein.—Although very vigorous and a fairly heavy yielder, this variety is no longer recommended for planting because of poor fruit quality: apart from lack of flavour it is subject to "Bitter Pit" and physiological cracking.

Sharps Early.—Probably the best early variety for Kenya, it is a rather weak grower and should be worked on a vigorous root-stock such as seedling Crab. The fruit though small, is highly coloured and attractive, the flesh is crisp and the flavour excellent. Experimental pre-packing of this variety in 1-lb. punnets with cellophane top is proving very successful: packed in this way the fruit is sold readily at Sh. 2 per lb. wholesale.

Abundance.—A late variety and a regular bearer though in a wet season rather susceptible to Scab. The fruit is small but of very good quality, the flesh is crisp and of delicate flavour: it keeps satisfactorily for 3 months in the storage cellar at Molo.

Ballarat Seedling.—A late variety, not a strong grower and therefore requires a vigorous rootstock. The fruit is large and of attractive appearance but not of high quality for eating: it is very suitable for cooking and will keep as long as Abundance in storage, [1], [2].

Growers who have planted unsatisfactory varieties are reminded that, provided the trees are healthy and vigorous, it is better to graft them over to another variety by the frameworking method, than to pull them out and replant.

PLUMS

The annual glut of poor quality plums on the local market has a very depressing effect on the price to growers but not so much on the price to consumers. The glut is due mainly to the Methley variety which has a strong tendency to overbear and produce heavy crops of very small fruit, often in alternate seasons. In order to overcome this unsatisfactory situation, trials of methods of thinning the crop have been carried out at Molo. Spraying with chemicals, D.N.O.C. and maleic hydrazide, has proved unsatisfactory and impractical under local conditions: thinning by hand, however, has given some very encouraging results.

The method used for hand thinning is very quick and effective. A loop of rubber V belting is fastened to the end of a short stick and, when the young fruit is about $\frac{1}{2}$ " diameter, the loop is rubbed up and down the underside of each branch, knocking off a considerable proportion of the fruit. As a result, the fruit remaining on the tree becomes very much larger, thus increasing the proportion of grades one and two and decreasing grade three and undergrade. The following table gives detailed results for two thinned and two unthinned trees:—

TABLE I

Grade	Unthinned	Thinned	Unthinned	Thinned	Value
	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	
Undergrade	43	—	28	—	No cash value.
Grade 3	143	11	211	42	30 cents per lb.
Grade 2	11	21	6	66	45 cents per lb.
Grade 1	2	40	1	54	75 cents per lb.
Total	199	72	246	162	
CASH RETURNS (SH.)—	<i>Sh. cts.</i>	<i>Sh. cts.</i>	<i>Sh. cts.</i>	<i>Sh. cts.</i>	
Grade 3	42 90	3 30	63 30	12 60	at 30 cents.
Grade 2	4 95	9 45	2 70	29 70	at 45 cents.
Grade 1	1 50	30 00	0 75	40 50	at 75 cents.
Total Value	49 35	42 75	66 75	82 80	{ Cost of non-returnable packing boxes at Sh. 1/40 to hold 20 lb.
Less boxes	13 93	5 04	17 22	11 34	
NET RETURN	35 42	37 71	49 53	71 46	

The extra cost of labour for picking and packing the greater weight of crop from the unthinned trees and the extra cost of transport has not been taken into account. The cost of thinning the crop has to be offset against those items: this cost would be considerably less than the cost of the extra picking alone, [1], [2], [3].

Pre-packing of grade one plums, in the same way as for Sharp's Early apples, has been very successful. The price obtained for several consignments was constant at Sh. 2 per lb. wholesale, [1], [2].

PEACHES

There is now a demand for peaches suitable for canning for export. Our present exports of canned fruit are confined to pineapple and this results in marketing difficulties through competition with other producing countries which are able to offer several kinds of canned fruit together.

Trials of canning peach varieties have so far been very discouraging because all of the varieties tried, with the possible exception of Kakamas, have too great a chilling requirement for our conditions. Trials of additional varieties were started at Molo, Burnt Forest and Subukia this year. Selection and trial of local clingstone peach seedlings is considered more likely to produce a suitable canning peach for our conditions than trials of imported varieties. Samples of fruit from seven selections at Burnt Forest and one at Londiani were canned at Molo and compared with a canned sample of Kakamas. Sample cans were submitted to local canners for an opinion. Reports on three of the Burnt Forest selections were considered sufficiently favourable to justify large scale trials and arrangements were made to have them propagated by a local nurseryman. It is expected that trials will be planted in 1957 and the search for additional selections will be continued, [1], [2], [3].

The dessert peach, Ventura (*see* Annual Reports for 1953, 1954), produced a reasonable crop at Molo this season, the quality of the fruit has definitely improved. A point in favour of this variety is the lack of a beak or nose on the fruit, beaked fruit are very susceptible to damage through rotting at the point. Ventura was marketed successfully this season, the dark red fruit packed in 1 lb. punnets had a very attractive appearance and fetched a good price. It is recommended to growers for trial as a market variety, [1], [2].

CITRUS

Investigational work on citrus was continued at Matuga, Ruiru and Kitale: there were no results of a sufficiently conclusive nature to be included in this report.

AVOCADOS

As there is a possibility of developing an export trade in avocados, future commercial plantings should be of varieties which are suitable for the purpose: such varieties will also prove better suited to the local market than those grown at present. Most avocados planted in the past were seedlings of the West Indian type. The fruit from these, owing to its thin skin, is easily damaged: it is also susceptible to internal bruising by the loose seed which rattles about inside the fruit during transport. This type of fruit is, therefore, unsuitable for export and undesirable on the local market. The planting of seedlings is not recommended because of the long time (7-12 years) which elapses before they come into bearing, and because of the variation in fruit characters which occurs among seedling trees. A small fruit is required for export because sales are normally per fruit, not per lb.; the fruit must also be able to withstand normal conditions of transport when properly packed and must keep in good condition for a reasonable length of time. Variety trials in progress at Ruiru and Kitale indicate that the Fuerte avocado is the most suitable for export. It starts to bear reasonable crops at four to five years from planting and the fruit characters are those

required, also it is an important commercial variety in other producing countries. It is not advisable to plant one variety only as avocados normally require cross pollination. Little is known about this problem at present under Kenya conditions but satisfactory crops are being obtained at Ruiru and Kitale from both Fuerte and Mayapan where these varieties are planted together. Mayapan is a less desirable commercial variety than Fuerte owing to the large size of the fruit: it is therefore suggested that only alternate trees in alternate rows should be planted with the Mayapan variety, [1], [2], [4].

Pineapples

The canning industry has had to face increased competition in the sale of canned pineapple overseas, but increased production by both European and African growers is enabling canneries to operate with a bigger turnover and to be more selective in the quality of fruit accepted for canning.

Export of fresh pineapples to England by air was continued on a small scale. An important development was the successful export of trial consignments of fresh pineapples by sea, which was carried out by the Horticultural Co-operative Union. Further consignments were held up at the end of 1956 pending re-opening of the Suez Canal.

In the Long Rains the development of the new Horticultural Research Station at Thika was sufficiently advanced to enable some pineapple trials to be planted there. Altogether fifteen trials are in progress in the Thika area, some of which are designed to investigate the influence of fertilizers, soil fumigation and mulch on yields from both replant and virgin soils. Other trials are concerned with the reaction of pineapples to different soil types, particularly to vlei and black cotton soils when these have been drained by various methods of ridging. Spacing and ridge cultivation of pineapples on red volcanic soils are also being investigated, as are the effect of semi-arid, low-altitude conditions on growth and yield; a comparison of different types of planting material and methods of pre-planting preparation, artificial flower induction on ratoon crops, and weedicides to control both couch and broad-leaved weeds, [1], [4].

Fertilizer and Soil Fumigation Trial (2⁴ Factorial)

This trial, which was at Karimaini Estate, Thika, was commenced in April, 1951, and is now complete having reached the second ratoon crop. Results of the plant crop and first ratoon crop have been published in the Annual Reports, Volume II for 1953 and 1955.

The yield results of the second ratoon crop show that nitrogen in the form of sulphate of ammonia has again had the greatest influence. The mean treatment yields per acre were 11.47 tons for the N. treatment and 9.67 tons for the nil treatment. The significant treatment effects, which are based on 10,000 plants per acre, are shown below:—

TABLE II—SECOND RATOON CROP
Significant treatment effects

TREATMENTS	Yields Tons/acre	No. of fruits acre	Mean weight per fruit/lb.
N.	+1.34	+1,061	3.30
D.	—2.62	—1,415	3.11
N. Mg. ..	—1.35	—916	3.29
Mg. D. ..	—	—770	3.27
L.S.D's 5 per cent	1.26	765	—
1 per cent	1.69	1,021	—

Though the sulphate of ammonia has significantly increased the yield, the increase has been brought about by the increased number of plants producing fruits and not by increasing the mean fruit weight as was a feature of the previous crops taken from this trial. The soil fumigant (treatment D) maintained its suppressing influence on yield and the number of plants producing fruits, but had no significant influence on suppressing fruit weight. Magnesium in the presence of N. has reduced the effect of the sulphate of ammonia as evidenced by the significant negative interaction.

The overall yields from the complete cycle were 39 tons for the N. treatment and 30.5 tons for the nil treatment. The soil fumigant, ethylene dibromide, which suppressed the crop so seriously resulted in only 22.1 tons.

Results of the trial indicate that a pineapple cycle on replant murram soils is capable of reaching the second ratoon crop if sulphate of ammonia is used and thinning is carried out so that only one sucker per plant is retained. The condition of plants after the second ratoon crop had been harvested was such that an economic third ratoon crop was unlikely because of the high percentage of plants which are now either dead or moribund, [4].

Interbed Fertilizer and Mulch Trial (2⁴ Factorial)

This trial was started at Karamaini Estate, Thika, in April 1953 and reports on its early progress will be found in the Annual Reports for 1953 and 1954. The treatments were N. as sulphate of ammonia at 1,200 lb., 600 lb. and 300 lb. per acre; P. as double superphosphate at 200 and 100 lb. per acre; K. as muriate of potash at 200 lb. per acre, and mulch applied once directly after planting.

Harvesting of the plant crop commenced 22 months after planting. The significant treatment effects are given in Table III.

TABLE III—PLANT CROP
Significant treatment effects

TREATMENTS	LEVELS				L.S.D's
	0	1	2	3	
Yields per acre/tons:					
N. 	7.4	12.5**	8.5	7.8	2.64* 3.18**
No. fruit/acre:					
N. 	5,872	7,492*	6,060	5,894	1,631*
M. 	5,694	6,926*			1,498*
Mean weight per fruit/ lb.:					
N. 	2.95	3.75***	3.17	3.07	0.25* 0.34** 0.46***
M. 	3.38**	3.09			0.18* 0.24**

Sulphate of ammonia (N) at the rate of 1,200 lb. per acre has significantly increased the yield per acre by causing an increase in mean fruit weight and the number of fruits produced. Superphosphate or potash had no significant influence whatever. There was some evidence that mulch in the presence of N increased the yield, but the effect was not quite significant: moreover, the combination, while significantly increasing the number of fruits per acre, caused a significant decrease in mean weight per fruit.

The harvesting pattern shows that a tremendous influence was exerted by N, by accelerating the harvest and also by increasing the number of fruits of 4 lb. and over. Potash also showed some superiority over the superphosphate and mulch treatments by accelerating the harvest, [4], [11].

Camber Bed, Vlei Soil Fertilizer Trial (2³ Factorial)

Early results are given in the Annual Report for 1954. This trial, which is at the Coffee Research Station, Ruiru, has now produced the plant crop. The trial was commenced in March 1954 with the main object of studying the growth and yields of pineapples on vlei type soils when the physical structure of this soil is improved by drainage in the form of 24 ft. wide cambered beds. The camber bed technique is described in detail in a paper by Robinson, Brook and De Vink in the *East African Agricultural Journal*, Vol. XXI, No. 2, October, 1955. The fertilizers used in the trial were sulphate of ammonia at 10 cwt. per acre, double superphosphate at 4 cwt. per acre and cattle manure at 10 tons per acre. The sulphate of ammonia was applied in two applications at the rate of 5 cwt. per acre each; the first application was made two months after planting and the second two months later. The cattle manure and superphosphate were applied just before planting time. The spacing used was 1 ft. between plants, 2 ft. between rows and 3 ft. between the two-row beds: on the camber bed system this spacing gives 14,520 plants per acre. The planting material was fruit crowns.

Harvesting of the plant crop commenced 22 months after planting and continued for a period of seven months. A summary of the significant treatment effects is given in Table IV.

TABLE IV—PLANT CROP
Significant treatment effects

TREATMENTS						Yield per acre/tons	Mean weight per fruit/lb.
N.	..	..	..	..	..	+1.89**	+0.264***
P.	..	..	..	..	..	—	+0.127*
CM.	..	..	..	..	..	+3.38***	+0.394***
L.S.D's	5.0 per cent	..	..	..	..	1.32	0.104
	1.0 per cent	..	..	..	..	1.79	0.142
	0.1 per cent	..	..	..	..	2.42	0.192

The mean treatment yields per acre were 22.72 tons for the nil treatment, 26.04 tons for the sulphate of ammonia, 23.62 tons for the phosphate and 27.21 tons for the cattle manure. Sulphate of ammonia and the cattle manure both produced significant increases in yields in terms of tons of fruits per acre, and both had a highly significant influence on mean weight per fruit. Superphosphate also had a significant effect on mean weight per fruit, but did not influence the yield per acre. There was no influence from any of the fertilizers on the number of fruits produced, but this soil type had a greater influence in increasing the number of fruit produced than was the case in other trials conducted on murram type soils and Kikuyu red loams, [4], [10].

Flower Induction Trial

This trial was carried out at Karamaini Estate, Thika, to study the influence of plant hormones on the fruiting of unthinned second ratoon crop suckers. The treatments were applied to single plots which originally consisted of 100 plants each. Treatments were applied in May 1955 during the long rains

period, by means of a mist spray. Harvesting of the fruit commenced eight months after treatment. The five treatments which were used in the trial are given in Table V which also shows the yield results on a plot basis:—

TABLE V
Results of hormone treatments

Treatments (in water) ..	“Hortomone” A	Planofix	I-Naphthylacetic acid		Control
Concentrations	1.0 cc.:500 cc.	0.75 cc.: 500 cc.	1.5 grms.: 3 gal.	2.0 grms.: 2 gal.	
No. fruits harvested at { months after treat- ment { (Cumulative) {	8 9 10 11	20 81 121 122	13 54 140 171	9 21 95 136	15 30 39 42
Mean weight per fruit lb.	2.2	2.0	2.0	1.2	3.2
Weight of fruit per plot lb.	319	244	342	162	134

The loss of mean weight per fruit as a result of the hormone treatments is due to the fact that large numbers of undersized suckers were induced to produce fruits. Though all the fruits of the hormone treatments were harvested in 11 months after application, harvesting of the control plot was continued up to the 18th month but even so only a further 32 fruits were harvested giving a total plot weight of 236 lbs, [4].

Foliar Spray Trials

Observational trials have been carried out to study the influence of foliar sprays on pineapples in an attempt to find the cause of serious chlorosis of the foliage. Sprays containing Urea at 4 per cent, and Urea plus Iron and Manganese at 0.1 per cent in chelated form, were applied to poorly-coloured, yellowish to reddish plant-crop plants growing on bench terraces. Sprayings were made at three-weekly intervals, and after the second spraying slight colour improvement was observed in the N.Fe.Mn. treatment. By the fourth spraying, colour improvement was more evident, the N treatment showing slight effect and the combination treatment a more marked effect.

On Kereti Estate, Thika, another trial was undertaken using two treatments, Urea at 5 per cent and Ferrous sulphate at 2 per cent. On this estate, yellowing of a first ratoon crop growing on good, deep Kikuyu red loam had become acute. Sprayings were made at intervals of three weeks and colour improvement as a result of the iron treatment was observed by the sixth week. By the ninth week, or by the time of the fourth spraying, the plants had attained almost normal colour. The Urea treatment had no influence whatever.

On soils where iron deficiency is known to occur, routine foliage sprays will be necessary before the appearance of chlorosis if the crop is to obtain the maximum benefit. The number of sprays required for this purpose will be determined by further experiments.

Pineapple Trials in Nyanza.—The observational pineapple trials planted in September, 1954, in Nyanza Province have now borne the plant crop: early results are given in the Annual Report for 1955, page 142. Yield figures, unfortunately, are unreliable, owing to thefts of fruit and the difficulty of recording such scattered trials, but the following conclusions can be drawn. Economic crops of good quality fruit can be produced in Nyanza, down to Lake level, provided (a) the crop is grown on land which has been under bush fallow for 5 or more

years, (b) where planting is on depleted soils, adequate quantities of nitrogen in the form of sulphate of ammonia or F.Y.M. are applied, (c) adequate drainage of black cotton soils is ensured by suitable ridged beds (d) control of mealybug is carried out where necessary. On some depleted soils, mulch alone appears to have had a beneficial effect and this has been even more marked when mulch has been combined with sulphate of ammonia. This is in accordance with results obtained with mulch at the Coast, but is the reverse of results at Thika.

A large number of sugar/acid tests carried out at Molo with fruit from the trials show that Nyanza fruit is less acid and contains rather less sugar than Thika fruit. Nyanza fruit is less sharp to the taste and has a more marked pineapple flavour and a better skin colour than Thika fruit. These characteristics make it a very suitable fruit for the fresh market and for this reason it has been recommended that fresh fruit exports should be developed with Nyanza fruit.

Samples of Nyanza pineapples from trials at 4,000 ft. and 5,000 ft. were canned at Molo. The canned fruit was inspected by Kenya Cannery Ltd. who reported that the fruit from both altitudes was of suitable quality for canning, [1], [2], [12].

Trial with Sulphate of Ammonia and Mulch at Kitale.—This observational trial was planted in July 1953 at a spacing of $3' \times 2' \times 1'$ on bench terraces and the plant and first ratoon crops have now been harvested. Yields generally were rather low, probably due to soil disturbance in making the bench terraces and to the presence of several old ant hill sites. Mulch had no effect, either alone or in combination with sulphate of ammonia. Plots receiving sulphate of ammonia at 1,500 lb. per acre gave a mean yield of 12.74 tons per acre in the plant crop, with a mean fruit weight of 3.95 lb.; in the 1st ratoon crop the yield was 10.24 tons per acre. The control plots gave a mean yield of 5.51 tons per acre and 7.43 tons per acre in the plant and first ratoon crops respectively. The higher yield in the ratoon crop was due to the proportion of "hang fire" plants which did not fruit during the plant crop. The quality of the fruit was high, good skin colour and the satisfactory shape of the fruit being particularly noticeable. Fruit from this area is considered to be suitable for export as fresh pineapples, [1], [2].

CULTURAL BULLETIN

A bulletin entitled "Notes on Pineapple Growing", describing the cultural methods recommended for pineapples based on the results of recent research, has been written mainly for the guidance of African growers. Copies are obtainable on request from officers of the Department, [4].

Berry Fruits

STRAWBERRIES

Improvements in the cultural treatment of strawberries resulting in very high yields, have been described in an article published in the *East African Farmer and Planter* for October, 1956, [2]. Briefly, the system recommended is deflowering of the plants except for cropping periods of eight weeks which are spaced six to eight months apart. The system has been developed and proved with the variety Cambridge Early Pine which has yielded at the rate of six tons or more per acre on three occasions at Molo over an eight weeks cropping period.

The 1 lb. chip punnet with cellophane top, the punnets themselves being packed in single layer cardboard cartons, has now been thoroughly and successfully tried out for strawberries on the local market, both by the Molo Station and by growers. The same pack would be suitable for air export as far as transport conditions are concerned, but it is likely that a punnet holding not more than 8 oz. will sell better in England at out-of-season prices, [1], [2].

YOUNGBERRIES

An article on the cultivation of Youngberries was published in the *East African Field, Farm and Garden*, September, 1956, [2]. There is now considerable interest in planting of Youngberries, but the fruit is not widely enough known on the fresh market: this is evident from the wholesale prices which ranged between Sh. 2 and Sh. 2/50, whereas first grade strawberries fetched Sh. 3/50 per lb. In our opinion the Youngberry is superior to the strawberry as a fruit. The cropping record of Youngberries planted at Molo in 1952 shows a progressive increase over the last three years: 1954, at the rate of 4,200 lb. per acre; 1955, at the rate of 6,216 lb. per acre; 1956, at the rate of 7,644 lb. per acre. The cropping rate is confirmed by the first crop this year from a later planting (1954) which was at the rate of 4,753 lb. per acre, [1], [2].

Vegetables

ASPARAGUS

An article on asparagus growing in Kenya was published in the *East African Field, Farm and Garden* in March, 1956, [2].

A new method of packing asparagus which keeps the produce in perfect condition for several days has been developed at Molo. After grading and trimming, the spears are tied in 1 lb. bundles and each bundle is inserted into a 6 in. wide plastic tube of fairly light gauge which has previously been sealed at one end. A few perforations are made in the walls of the tube to prevent excessive moisture condensation. Asparagus packed in this way has been marketed locally for some time and seldom fetches less than Sh. 3/50 per lb. wholesale. The method is considered suitable for asparagus which is to be exported by air to Europe; it has already been used successfully for air export to Tanganyika, [1], [2].

ONIONS

Closure of the Suez Canal resulted in supplies of Egyptian onions, which are normally imported into Kenya and Uganda in large quantities, being cut off. This provided an excellent opportunity for developing onion growing in Kenya, for the local market and for export to neighbouring territories. To investigate the possibility of producing an onion with reasonable keeping qualities, a series of trials was planted in different climates with onion sets, no seed of suitable varieties being available at the time. Preliminary results indicated that onions of reasonable quality can be economically produced from sets. The Bombay variety is already being successfully produced from Indian seed on a considerable scale in Lumbwa district and in other parts of Nyanza. Production of suitable onions is therefore possible from either seed or sets.

Sets of three varieties were used in the trials, Egyptian, Tanganyika (Bombay Red), and a local variety known as Uplands. The sets used were ordinary ware onions, as selected sets (diameter $\frac{3}{4}$ "– $\frac{1}{2}$ ") were not available. The use of large bulbs for planting resulted in losses through flower stalk production; and, through lack of experience with the crop, losses also occurred through deep planting and premature harvesting.

At Molo, where sets were planted in an attempt to produce seed, all varieties were attacked by Mildew, *Peronospora destructor*, owing to out-of-season rain. The disease destroyed the Egyptian and Bombay varieties, but the Uplands onion recovered. Although no seed was produced, a fair crop of bulbs was harvested which are now being multiplied for distribution as planting sets, [2], [3].

Uplands also proved resistant to Mildew at Taveta when compared with Tanganyika and Egyptian: it was also the only variety in this trial where weight of harvest exceeded the weight of sets originally planted, [7].

At the Perkerra Irrigation Scheme, Uplands and Egyptian yielded at the rate of $6\frac{1}{2}$ tons per acre, while Bombay gave only $3\frac{1}{2}$ tons. As this trial appears to have been harvested prematurely, the yields recorded are probably lower than they should have been. Superphosphate at 1 cwt. per acre resulted in a mean increase in yield over the three varieties of 0.61 tons per acre, [8].

The trial at Machakos is not yet complete but the indications are that Uplands will be superior to Egyptian and Bombay in yield, it is also producing far less flower stalks than the other varieties, [13].

The following conclusions can be drawn from these trials:—

(a) Uplands appears to be particularly suitable as a multiplier onion, i.e. planted from sets, and it is also very disease resistant. The size of bulb is small but it appears to have good keeping qualities. (b) Superphosphate at 1 cwt. per acre has given a worthwhile return at Perkerra and this result should be followed up on a larger scale both at Perkerra and in other areas. (c) Bombay Red and Egyptian do not appear to be very suitable varieties for multiplication by sets. As seed of Bombay Red is now available, it is recommended that this variety should be grown from seed, it is already in production locally and is a good quality market onion with reasonable keeping qualities.

TOMATOES

The installation of a modern tomato *purée* plant by Kabazi Cannery Ltd. marked the start of production in what may prove to be an important new branch of the industry. The initial acreage of tomatoes was grown at the Perkerra Irrigation Scheme.

In order to confirm and follow up results of trials on the production of canning tomatoes carried out in 1954–55 (see Annual Reports 1954 and 1955) further trials were planted during the 1955–56 season at Hoey's Bridge, the Perkerra and Mwea Irrigation Schemes, Tana Ranch, Machakos and Taveta. In all the trials the plants were unpruned and unstaked.

The trial at Perkerra showed that for unstaked canning tomatoes it is essential that the soil is not flooded because this causes rotting of the fruits which lie on the ground and a microclimate which favours disease. For such unstaked and unpruned tomatoes, irrigation water must be confined to one furrow for each row of plants.

At Tana Ranch the trial failed owing to a combination of pests, diseases and soil deficiencies. The most promising yielders were Break O'Day, Salvatore ovale, Salvatore rotondo, Early Red and San Marzano, [4].

At Ngelani Farm, Machakos an unirrigated trial was sown on 7.4.56, transplanted on 7.5.56, came into bearing on 7.8.56 and was completed on 28.9.56. The seed bed was watered and each plant received four applications of two gallons of water within two weeks of planting out, after this the plants had to subsist on the rainfall which totalled only 0.78 in. for the whole period of the trial. Under these conditions the yields obtained were remarkably high, mean yields from four plots of each variety were as follows: Sunrise 12.5, Break O'Day 2.4, Best of All 15.5, and San Marzano 11.5 tons per acre. Such very dry conditions do not favour tomato diseases and lack of disease was a contributing factor in the yields obtained, [13].

The trial at the Mwea Irrigation Scheme was of 12 varieties with duplicate plots of each: it was sown by the direct seeding method on 8.11.55 at a spacing of $6' \times 2'$ and was furrow irrigated. Out-of-season rain and overcast weather occurred during December–January and, as the trial was not sprayed, a very severe attack of blight occurred which undoubtedly reduced yields very considerably. Defoliation owing to blight resulted in a considerable amount of sun scorch on the fruit. Harvesting started on 7.3.56 and finished on 21.4.56,

thus the harvest period ran into the long rains, a most unsuitable time for tomatoes, indicating that the trial was sown too late in the season. Yields were as follows:—

TABLE VI

VARIETY	Yield, tons per acre	No. of Fruit in 2 lb.	Colour of Fruit	Brix of juice
Lampadina	11.88	22	Medium to good ..	6.0
Strain 7	11.18	25	Medium to good red ..	7.5
San Marzano	10.65	25	Medium to good red ..	7.0
Salvatore ovale	8.82	57	Medium red	6.5
Salvatore rotondo	7.94	49	Medium red	5.7
Break O'Day	8.62	22	Good red	6.6
Costoluto Paullo	7.04	9	Medium to good red ..	7.2
Genovese	6.77	11	Poor	6.7
Homestead	6.33	18	Good	7.0
Bonny Best	5.70	15	Medium red	7.0
Early Red	5.41	9	Poor	6.0
Marglobe (bad germination)	0.70	15	Medium to good red ..	7.0

Lampadina, San Marzano and Early Red were best for colour of juice, the two latter varieties the best juice flavour. All other varieties had poor juice colour. Brix of juice was uniformly high. The report on fruit quality is by Mr. Dickson of Kenya Cannery Ltd. and is acknowledged with thanks, [9].

The trial at Hoey's Bridge was on Mr. G. K. Irwin's farm and contained 14 varieties, duplicate plots of 100 plants of each. Sowing by the direct seeding method took place on 26.10.55, which is too late in the season to finish the harvest before the onset of the long rains. The plants were spaced at 6' x 2', and were furrow irrigated, supplementing rainfall to make a total of 1 in. per week. Out-of-season rain in January caused an attack of Blight, spraying with Perenox at 7-10 days intervals enabled partial control of the disease but there is no doubt that some reduction in yield occurred. Harvesting started at the beginning of February and continued into mid-April, yields were as follows:—

TABLE VII

VARIETY	Yields, tons per acre	Remarks
Bonny Best	20.8	Susceptible to blight.
Costoluto Paullo	16.5	Very susceptible to blight.
San Marzano	25.5	Fairly resistant to blight.
Early Red	14.5	Very susceptible to blight.
Salvatore rotondo	11.0	Extremely susceptible to blight.
Homestead	18.8	Susceptible to blight.
Marglobe	18.4	Susceptible to blight.
Lampadina	23.6	Fairly resistant to blight, rather susceptible to sun scorch.
Salvatore ovale	10.6	Extremely susceptible to blight.
Break O'Day	20.1	Susceptible to blight and sun scorch.
Strain 7	22.7	Fairly resistant to blight.
Genovese	17.6	Susceptible to blight.
Tondino	18.2	Similar to San Marzano.
Pearson	17.4	Rather susceptible to blight and sun scorch.

In spite of Blight attack, yields were good and confirm the opinion that the Trans Nzoia is a favourable area for production of canning tomatoes, [1], [2].

PEAS

Trials of peas in connexion with the fresh market, canning and seed production were carried out at Molo, Mwea—Teberre Irrigation Scheme, Machakos.

At Mwea, the Dutch Blue pea, Unica, was tried as a rotation crop for rice, unfortunately the peas failed completely owing to attack by Mildew, [9].

Four varieties of green pea were tried at Ngelani Farm, Machakos. Sowing was carried out on 1.5.56 and harvesting completed on 8.8.56. During this period only 1.14 in. of rain fell and yields were therefore negligible, it is however worth recording that under those extremely unfavourable conditions the variety Clipper yielded at the rate of 1,144 lb. green peas per acre, [13].

Results of the canning tests carried out at Molo on samples from the trial of canning peas, described in the Annual Report for 1955, page 155, were as follows: Samples canned between 10th and 22nd November, 1955, were opened and examined by a panel of 3 (including one canner) on 28.3.56. Varieties were placed in order of merit for flavour as follows: 1 Onward, 2 Kelvedon Wonder, 3 Laxton's Superb, 9 Unica, 10 Mansholt's Pluk, the last two are processing varieties. The best varieties for appearance were Onward and Kelvedon Wonder, classed as equal. The size of individual peas in all varieties was too uneven to compete as an export pack to the United Kingdom, [1], [2].

A plot of Unica peas sown at Molo during May yielded at the rate of only 77 lb. dry peas per acre. This confirmed the opinion that in Molo peas should be sown only towards the end of the rains, (mid-August). A seed production trial of nine varieties was sown at Molo August 18th–22nd. Sowing by Planet Junior was compared with hand sowing after opening drills with a Ferguson cultivator; the latter method gave a far better stand of peas. The Planet Junior is not suitable for field sowing because of the fine tilth required for it to operate properly. A fine tilth usually results in much of the seed being washed out by heavy August rains. In early October Tropotox was applied as a weed killer to half the plot of each variety, at this time weeds were up to 2½ in. high. Tropotox was effective in killing the weeds and in suppressing their growth long enough for the peas to cover the soil; no damage to the peas was observed. Owing to prolonged out-of-season rain, the season for peas was a poor one and yields were well below those usually obtained at Molo. The highest yield from a green pea variety was Onward with 522 lb. per acre and of the Dutch Blues, Virtus was best with 1,416 lb. per acre. A local variety from Meru was included in the trial, this is a very late and long strawed variety; it is a typical field pea, the seed being yellow when ripe and very small, the yield of seed was 804 lb. per acre. This variety would be useful as a green manure or rotation crop, [1], [3].

TRIALS OF OTHER VEGETABLES

A considerable number of observational trials on other vegetables were carried out in the Taita Hills and at Taveta with the object of improving the local vegetable industry. Unfortunately space does not permit the reporting of these trials in detail but it is expected that the more interesting results will be published in the local Press, [7].

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APPENDIX A

IMPORTATION OF FRESH FRUIT THROUGH KILINDINI, 1956

KIND	Packages	Value in Sh.	Country of Origin
Apples	450	24,809	U.K.
Apples	8,454	281,612	South Africa
Apples	15,822	605,335	Italy
Apples	13,368	243,091	Australia
Pears	1,924	57,201	Italy
Grapes	1,780	38,475	Italy
Grapes	8,723	567,210	Spain
Apricots/Peach/Plum ..	968	29,800	Italy
Melon	23,992	366,086	South Africa
Citrus Fruits	8,679	398,600	South Africa
E.A. Fruits	4,993	57,086	
Fruit Trees	15	5,858	France
Fruit Trees	3	1,153	Holland
Fruit Trees	2	150	Tanganyika
Fruit Trees	752	82,560	South Africa
Onions	89,835	1,596,932	Egypt
Onions	10,567	146,580	India
Onions	1,343	28,118	South Africa
Onions	400	4,500	Singapore

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Meteorological

Detailed meteorological records for the various stations will be found in the Appendix to this Report.

Rains which had started in December, 1955, continued all through January and February, 1956, and this resulted in a prolonged flush of flowers. In fact, most of the 1955 plantings never ceased flowering and were not cut back at all in many cases, while older plantings dried up in February or March. Flower deliveries during the first three months of the year were exceptionally heavy. During the last third of April rains started again and the first plots were planted at the beginning of May. A set-back occurred in June which was very dry for the first 20 days and a number of plants were lost. Rainfall for the next three months was up to average but the figures for daily sunshine hours were low. After September, however, rains were sparse, especially at Ol Joro Orok. On the whole flower yields per acre have been less than in the preceding season and the pyrethrins content was also slightly lower with an average of 1.50 per cent for the Colony (1.53 per cent in 1955). The total deliveries of dried flowers amounted to 7,037,289 lb. or 1,038,505 lb. more than in 1955, due mainly to an increase in acreage. Lack of sun during the latter half of the year encouraged the spread of the fungus *Ramularia bellunensis*.

Experimental Work

MANURIAL TRIALS

Two identical experiments were planted on the Grassland Station and at Ol Joro Orok in 1954. At Ol Joro Orok, manurial treatments or cultural methods had no effect in any season. On the Grassland Station, however, 150 lb./acre triple superphosphate effected a yield increase of 102 lb./acre dry flowers in the first season and a further one of 148 lb. in the second year; no significant treatment differences were recorded in the final season. Planting on ridges resulted in a yield increase, which was, however, of no statistical significance. Farm yard manure and dry cow dung were without any effect.

PHOSPHATE/RIDGING TRIALS

No new trials of this type were planted in 1956. The series planted in 1954 gave the following final results, covering three seasons:—

TREATMENTS	YIELD LB./ACRE DRY FLOWERS	
	Ainabkoi	Kinangop
A.—On flat, no phosphate	955	3,068
B.—On flat, 300 lb./acre Triple Supers. in plant. holes ..	1,156	3,187
C.—On ridge, 300 lb./acre Triple Supers. in plant. holes ..	1,155	—
D.—On ridge, 300 lb./acre Triple Supers. at base of ridge ..	1,003	3,927
E.—On ridge, 100 lb./acre Triple Supers. in plant. holes, 200 lb. at base of ridge	1,279	—
F.—On ridge, no phosphate	1,018	3,242
G.—On flat, 750 lb./acre Soda Phosphate in plant. holes ..	916	3,137
H.—On ridge, 750 lb./acre Soda Phosphate in plant. holes ..	919	3,580
Average Effect of Triple Superphosphate	+162	**+402
Average Effect of Soda Phosphate	—69	+204
Average Effect of Ridge planting	+66	+304

**Significant at $P=0.01$

The experiment at Ainabkoi was sited on red, former forest glade soil, while the Kinangop plot was laid down on cleared bush land, ranging in colour from orange to red, a transitional type between grassland and forest soil. In this trial, the yield increase from 300 lb./acre triple superphosphate placed below the ridge reached statistical significance in the first season only.

The two trials planted in 1955 yielded the following results (in lb./acre dry flowers) over two seasons:—

TREATMENTS	Dundori	Nanyuki
A.—On flat, no phosphate	245	779
B.—On flat, 300 lb./acre Triple Supers. in plant. holes ..	724	872
C.—On ridge, 300 lb./acre Triple Supers. in plant. holes ..	793	954
D.—On ridge, 300 lb./acre Triple Supers. at base of ridge ..	746	1,160
E.—On ridge, 100 lb./acre Triple Supers. in plant. holes, 200 lb. at base of ridge	861	1,080
F.—On ridge, no phosphate	251	938
G.—On flat, 750 lb./acre Soda Phosphate in plant. holes ..	425	745
H.—On ridge, 750 lb./acre Soda Phosphate at base of ridge	559	1,019
Effect of Triple Supers.	+534**	+174
Effect of Soda Phosphate	+251**	+23
Effect of Ridge planting	+180	+231

**Significant at $P=0.01$

The trial at Dundori is planted on reddish forest glade soil, the Nanyuki plot on rather richer and darker land. Here, rainfall may be a limiting factor. Ridge planting resulted in a significant treatment difference in the first season only at Dundori. Picking still continued at Nanyuki at the time of writing; both superphosphate and ridging indicate yield increases.

Another series of experiments was started in 1955, comparing planting on the flat with ridge planting and using four levels of triple superphosphate (0—150—300—450 lb./acre). Results of three of these trials for two seasons have been as follows (lb./acre dry flowers):—

TREATMENTS	Grassland Stn.	Kinangop	Kipkabus
On flat, no phosphate	1,011	1,343	305
On flat, 150 lb./acre Triple Supers.	1,320**	1,507*	420
On flat, 300 lb./acre Triple Supers.	1,273**	1,577*	401
On flat, 450 lb./acre Triple Supers.	1,165**	2,018**	275
On ridge, no phosphate	1,103	661	597**
On ridge, 150 lb./acre Triple Supers.	1,461*	1,480*	629**
On ridge, 300 lb./acre Triple Supers.	1,539**	2,317**	636**
On ridge, 450 lb./acre Triple Supers.	1,518**	2,282**	672**
Average Effect of Ridge Planting	+213**	+74	+283**
Average Effect of Supers.	+322**	+862**	+54

**Significant at $P=0.01$

*Significant at $P=0.05$

It is obvious that on the Grassland Station heavier dosages than 150 lb./acre triple superphosphate were of no economic value, while the average response to phosphorus was considerable. The interpretation of the results on the Kinangop is more difficult, mainly because the trial has suffered severely through waterlogging which was most evident, unfortunately, in the Control plots on the ridge. This has masked the effect caused by ridge planting. The experiment will have to be repeated on a more suitable site in the area, for the effect of the higher fertilizer rates is also obscured. The experiment at Kipkabus has shown no significant treatment differences between plots with and without superphosphate but a clear indication as to the advantage of planting on ridges.

As the heavy application of 450 lb./acre triple superphosphate seemed to produce no increased effect, with the possible exception of Kinangop, the trials planted in 1956 were simplified and three levels only (0—150—300 lb./acre) of fertilizer were used. These experiments were planted at Lumbwa, Thomson's Falls, Dundori and Nanyuki. So far, only preliminary results are available but it appears that ridge planting caused a marked yield increase at Lumbwa and Nanyuki while a positive effect of superphosphate was registered at Thomson's Falls only.

The Senior Pyrethrum Officer wrote a paper "Some Notes on Phosphate Responses in Pyrethrum" in which results over a number of years and to date were summarized. It is of great interest to correlate the responses with the soil analyses, for it is found that, in general, only soils with a fairly low base exchange capacity (saturation 70 per cent or below) reacted to phosphatic dressings. Soils of this type occur mainly on the high veldt of Molo, Dundori, Ainabkoi, Kipkabus, Thomson's Falls and on certain parts of the Kinangop and Londiani. A number of factors probably combine to bring about the yield increase recorded in several instances of ridge planting: the young plant thrives in the loose soil which consists almost entirely of rich top soil, the danger of waterlogging is diminished, which is important in certain areas; it is also to be expected that soil temperatures rise more rapidly within the ridges than on flat land, and finally, ridges following the contour lines would prevent a run-off of the rain and so preserve moisture. As ridge planting presents further great advantages in cultivation, it can generally be recommended.

STRIPPING TRIALS

One trial was planted at Molo in 1954, with clone 194, while another was established at Ol Joro Orok with clone 24, in 1955. The aim of these experiments is to study the question whether it is important to pick flowers with horizontal petals only (PH), or whether stripping down to and including flowers with vertical petals (PV) or Buds (B) will give equally satisfactory results. This point would attain significance if mechanical pickers were introduced. As previously reported, in the first two seasons picking down to and including buds had a detrimental effect on the yields of pyrethrins. In the first year no difference was recorded between stripping to petals horizontal and vertical respectively, while in the second season the results were in favour of stripping down to flowers with horizontal petals only. Yield figures (in lb./acre pyrethrins) for the third season are as follows:—

			Petals horizontal	Petals vertical	Buds	Average time
2 weeks	..	..	24·30	24·71	16·23	21·75
3 weeks	..	..	20·15	21·75	17·17	19·69
4 weeks	..	..	22·31	22·78	19·92	21·67
6 weeks	..	..	17·04	17·56	19·99	18·19
Average stripping	..		20·95	21·70	18·33	

Significant treatment differences for (a) stripping methods:—

P=0.01	P=0.05
1.43	1.06
(b) Stripping × time:	
P=0.01	P=0.05
2.86	2.11

Stripping down to buds had, for the third time, a depressing effect on the pyrethrins yield. Picking at two-weekly intervals seems, generally speaking, to give the best results. It is interesting that the flower samples including a high percentage of PV gave an equally high yield as PH.

Taken over the three seasons 1954-1957, the following results were calculated:—

	Petals horizontal	Petals vertical	Buds	Average time
2 weeks	66.77	63.14	40.55	56.82
3 weeks	59.17	58.71	43.99	53.96
4 weeks	60.18	60.20	53.26	57.88
6 weeks	48.88	48.56	54.44	50.63
Average stripping	58.75	57.65	48.06	

Significant treatment difference for (a) stripping methods:—

P=0.01	P=0.05
3.75	2.77
(b) Stripping × time:	
P=0.01	P=0.05
7.50	5.54

It will be seen that a considerable loss in pyrethrins is incurred if stripping is extended down to and including buds, while very little or no difference is registered between stripping to horizontal or vertical petals respectively. Twice weekly PH has given the best results. When analysing the flower samples of the various stripping treatments, it was found that the portion of overblown inflorescences was well below ten per cent in the two- three- and four-weekly treatments, while especially in six-weekly PH and PV it rose to 20 per cent and more. This results in a considerable depression of the yields in pyrethrins, for if flowers are allowed to mature on the plant to an advanced stage bud initiation is impaired. It may be as well to point out that at different altitudes (temperatures) the time required for the flower to mature varies. This experiment was conducted at an altitude of 8,300 ft. where it was observed that stripping at two weeks intervals produced the best results. At an elevation of 9,000 ft., where flowers mature more slowly, the optimum interval between strippings may be longer, and conversely, at lower altitudes the optimum interval may be shorter.

The experiment at Ol Joro Orok has given only poor yields during its first two years, largely due to seasonal factors. Stripping down to and including buds has not decreased the yields of pyrethrins, as it did at Molo. This may be due

to a different physiological behaviour of the two clones (24 and 194) used in the trials, or to the fact that stripping was not so severe at Ol Joro Orok, with the result that the percentage of buds contained in B was considerably lower and the portion of immature flowers higher.

LARGE ROTATION TRIAL

The object of this trial at Ol Joro Orok is to determine the most suitable place for pyrethrum in a balanced mixed-farming rotation. It was thought that the pyrethrum crop, with its need for constant weeding and picking, i.e. constant trampling of the soil, was bound to induce pulverization and loss of crumb structure which could only be rebuilt under a grass ley. The six rotations used include, therefore, leys of three or six years' duration respectively, and cereals for three years. The control consists of continuous pyrethrum which is replanted every three years. The experiment was established in three identical groups, planted in 1947, 1948 and 1949 respectively. The first group has, therefore, completed a course of ten years. In the plots bearing continuous pyrethrum, it was observed at a comparatively early stage that the top layer of the soil degenerated in structure, the run-off during heavy rains being considerable, but this has not so far resulted in a decreased flower yield. The grass leys are being grazed by sheep.

CUTTING-BACK TRIALS

These trials were established on four stations to test the effect on yield of cutting-back the early flowers for different periods after planting. The Control plots which were not cut back yielded more in the first season only.

Plant Breeding

The selection and testing of single plants (clones) is a continuous process. The majority of selected plants originate from populations of hybrids produced on the various stations, which means that the parentage of these clones is known and back-crossing and line-breeding methods can be employed if so desired. In 1956, 434 new single plant selections were made, a total of 635 being under observation. Two hundred and ninety-nine tested clones have by now been bulked up on the different stations and another 20 are being multiplied under irrigation at Londiani as parent material for improved hybrids to be issued in coming seasons. The following quantities of seed were delivered to the Pyrethrum Board for distribution to growers in 1956:—

C.43	..	..	..	..	..	..	571 lb.
C.47	..	..	..	..	..	..	237 lb.
C.51	..	..	..	..	..	..	308 lb.
C.79	..	..	..	..	..	..	3 lb.
100.A	..	..	..	..	..	..	686 lb.
Ol Joro Orok Bulk	..	..	..	..	..	..	150 lb.
Subukia Bulk	..	..	..	..	..	..	368 lb.
Total	..	..	..	..	..	..	2,323 lb.

At Molo, seed production fields were established for C.60 and C.79. Twenty-four new crosses (hybrids) were made in isolated plots at Molo and Ol Joro Orok, while 12 large isolated plots were laid down at Molo and Subukia for the third and second stage respectively of the "sugar beet" breeding systems. Hybrids bred in recent years, and some other varieties, were examined for their yield, pyrethrins content and general behaviour in 22 yield trials distributed widely over the pyrethrum growing areas. In most of these trials the hybrids C.35, C.51,

C.60 and C.79 maintained their reputation, and the following hybrids also produced remarkable yields: 0.1, 0.4, M.9, M.11, M.15, M.18, M.21 and 100.A

Further studies on pollination and seed setting have confirmed the findings of previous seasons, i.e. that viable seed can normally be obtained only through cross-pollination of different clones. Carriers of pollen are mainly beetles, flies, bees and possibly thrips. Selfing occurs only rarely and seems to be confined to certain clones and to be connected with seasonal conditions.

Pests and Diseases

Possibly due to lack of sunshine during the months of July, August, September and November, the fungus *Ramularia bellunensis* spread causing fairly heavy losses in yield, at least in certain areas. Other bud diseases, probably of a physiological nature, were observed as well. So clone 481, one of the parents of C.51, was prevented from developing healthy flowers until late in the season with the result that only very little seed of this hybrid will be available. The bud disease rate within single plant selections on the various stations was:—

	1953/54	1954/55	1955/56	1956/57
Molo	7.6	4.3	2.9	12.0
Ol Joro Orok	8.7	16.4	20.0	8.4
Grassland Stn.	0.6*	30.0	19.1	27.8
Subukia	6.0	11.4	2.6*	3.5

*First season plants only

Eelworms caused severe damage at least in one case, probably in connexion with other factors, and die-back occurred in patches on several farms. The reason for die-back is not always obvious and more physiological and pathological studies on this problem are desirable. Thrips infestations on flowers and foliage were observed towards the end of the year when drought conditions became more pronounced.

Publications

The Senior Pyrethrum Officer wrote a paper entitled "Some Notes on Phosphate Responses in Pyrethrum" which was published by the Pyrethrum Board mainly for the benefit of growers. The Senior Field Assistant made a broadcast on the cultivation of pyrethrum in Swahili within the series "Better Farming".

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U. KROLL,
Senior Pyrethrum Officer.

APPENDIX

METEOROLOGICAL DATA

Molo (altitude 8,300 ft.)

1956					Mean Temp. °F.	Rainfall (in.)	Sunshine (hr.)
January	..	..	..	..	55.8	6.20	200.8
February	..	..	..	..	56.1	3.17	248.5
March	..	..	..	..	57.3	2.20	244.8
April	..	..	..	..	58.3	3.74	172.9
May	..	..	..	..	57.2	4.09	176.5
June	..	..	..	..	53.9	5.52	205.7
July	..	..	..	..	54.5	6.46	157.5
August	..	..	..	..	55.0	5.53	159.4
September	..	..	..	..	55.2	4.76	184.0
October	..	..	..	..	56.2	1.65	242.9
November	..	..	..	..	56.2	2.57	198.8
December	..	..	..	..	56.1	1.00	235.2
MEAN					56.0	Total 46.89	2,427.0

Grassland Station (Marindas, Molo, Altitude 9,200 ft.)

1956					Mean Temp. °F.	Rainfall (in.)	Sunshine (hr.)
January	..	..	..	..	52.2	7.49	177.7
February	..	..	..	..	58.5	3.54	220.9
March	..	..	..	..	53.7	4.44	214.7
April	..	..	..	..	53.8	6.79	156.0
May	..	..	..	..	53.1	6.35	138.5
June	..	..	..	..	50.6	6.79	177.6
July	..	..	..	..	50.6	8.19	131.3
August	..	..	..	..	50.7	15.22	125.0
September	..	..	..	..	57.1	5.30	109.3
October	..	..	..	..	50.3	2.65	90.5
November	..	..	..	..	52.7	1.06	162.6
December	..	..	..	..	52.1	1.01	75.6
MEAN					53.0	Total 68.83	1,779.7*

*Incomplete.

Subukia (altitude 7,000 ft.)

1956					Mean Temp. °F.	Rainfall (in.)	Sunshine (hr.)
January	..	..	..	..	61.2	3.52	202.1
February	..	..	..	..	61.2	3.34	249.0
March	..	..	..	..	62.7	2.13	247.7
April	..	..	..	..	62.9	6.97	165.4
May	..	..	..	..	61.3	6.12	183.4
June	..	..	..	..	59.6	2.70	193.2
July	..	..	..	..	59.5	5.69	190.6
August	..	..	..	..	60.0	5.76	214.5
September	..	..	..	..	59.7	7.96	202.0
October	..	..	..	..	60.0	4.12	211.9
November	..	..	..	..	60.0	1.01	188.2
December	..	..	..	..	63.1	0.51	235.5
MEAN	..	..	..	..	60.9	Total 49.83	2,483.5

Ol Joro Orok (altitude 7,800 ft.)

1956					Mean Temp. °F.	Rainfall (in.)	Sunshine (hr.)
January	..	..	..	..	56.1	3.16	179.8
February	..	..	..	..	56.7	4.55	246.7
March	..	..	..	..	57.8	1.49	249.6
April	..	..	..	..	58.3	3.72	173.7
May	..	..	..	..	57.4	2.83	189.8
June	..	..	..	..	54.9	5.30	204.5
July	..	..	..	..	55.3	5.08	153.1
August	..	..	..	..	55.4	8.62	148.0
September	..	..	..	..	55.4	3.44	203.8
October	..	..	..	..	56.1	1.10	189.1
November	..	..	..	..	57.4	0.80	160.2
December	..	..	..	..	57.3	0.82	166.1
MEAN	..	..	..	..	56.5	Total 40.91	2,264.4

ANNUAL REPORT OF THE OFFICER IN CHARGE SISAL RESEARCH STATION, THIKA, 1956

Rainfall

				1956	Average previous 15 years
January	..	..	..	4.08" in 13 days	0.81" in 2.0 days
February	..	..	..	3.21" in 4 days	1.01" in 2.4 days
March	..	..	..	3.69" in 13 days	3.21" in 6.7 days
April	..	..	..	6.94" in 16 days	9.05" in 15.5 days
May	..	..	..	1.51" in 9 days	4.48" in 10.8 days
June	..	..	..	0.07" in 1 day	1.04" in 4.7 days
July	..	..	..	0.36" in 3 days	0.54" in 3.5 days
August	..	..	..	0.74" in 4 days	0.72" in 4.9 days
September	..	..	..	1.32" in 8 days	0.67" in 3.1 days
October	..	..	..	1.67" in 4 days	1.77" in 5.1 days
November	..	..	..	6.99" in 13 days	5.37" in 14.5 days
December	..	..	..	0.87" in 7 days	3.48" in 9.4 days
TOTAL	..	..	..	31.45" in 95 days	32.15" in 82.6 days

After the exceptional rains in December, 1955, the year began with exceptional rainfalls in January and February. March's total rainfall was about normal but was made up of many small showers; April and May were well below normal making the Long Rains disappointing. The Short Rains were satisfactory and the growth of sisal was well maintained.

Nursery Trials

NURSERY MANURIAL AND MULCHING TRIAL

Object.—To compare the effects of fertilizers and sisal waste on the growth rate of bulbils in nurseries.

Date of commencement

First cycle planted 28th November, 1950, lifted one year and four months later.

Second cycle planted 15th April, 1952, lifted one year and seven months later.

Third cycle planted 24th November, 1953, lifted one year and five months later.

Fourth cycle planted 18th April, 1955, lifted one year and six months later.

Fifth cycle planted 10th November, 1956.

Spacing.—2 ft. × 9 in. (29,040 plants per acre).

Treatments.—

N. 300 lb. sulphate of ammonia per acre.

K. 120 lb. muriate of potash per acre.

P. 180 lb. double super phosphate per acre.

C. 30 tons well rotted sisal waste dug in per acre.

M. 30 tons well rotted sisal waste mulched per acre.

Design.—2⁵ factorial confounded.

Although the responses to the treatments were disappointingly low in the third and fourth cycle there are certain indications that have become apparent since this trial has been in the ground.

The application of muriate of potash has consistently given a small and insignificant negative response indicating that it is of no benefit to the plants on this kind of soil when applied by itself or in these combinations.

The response to double superphosphate has been small and as far as weight per plant is concerned was only significant ($P=0.05$) in the second cycle. When measuring the average height for the fourth cycle there was a highly significant response ($P=0.01$), which however only meant an increase in height of about 2 in.

The responses to sulphate of ammonia have been consistently good with the exception of the third cycle and has increased both plant weight and plant height. It was the only fertilizer which gave a significant response in the fourth cycle increasing the average weight per plant from 2.85 lb. to 3.65 lb.

The effect of the applications of sisal waste was very pronounced in the first two cycles when the waste was dug into the top layer of the soil, but when left on the surface as a mulch was only just significant in the first cycle and has been insignificant in the other three cycles.

The lack of response to sisal waste dug into the top layer of the soil over the last two cycles is rather disturbing and must to a large extent be due to the unevenness of the plants lifted. In the fifth cycle the planting was done 11 days after application of the waste and not immediately after as in previous cycles. A keen watch is being kept on the trial to ascertain if there is any unevenness, and if so, when it becomes apparent. The predominance of weeds in the waste plots, entailing more hand weedings and root-disturbance may have something to do with the uneven growth.

The average weight per plant lifted over the four cycles was 4.06 lb., 5.62 lb., 2.56 lb. and 3.25 lb. The rainfall throughout the cycles amounted to 63.90 in., 42.23 in., 43.15 in. and 42.33 in. respectively. There would appear to be no relation between the variations in weight and rainfall during the four cycles.

NURSERY NITROGEN AND LIME TRIAL

Object.—To ascertain the effect on soil and sisal plants of various nitrogenous fertilizers with and without lime applications.

Date of commencement

First cycle planted 16th April, 1953; lifted 8th November, 1954.

Second cycle planted 15th November, 1954; lifted 31st July, 1956.

Third cycle planted 26th September, 1956.

Spacing.—2 ft. $\times$ 9 in. (29,040 plants per acre).

Treatments

A. Control.

B. 63 lb. N as 300 lb. sulphate of ammonia per acre.

C. 63 lb. N as 394 lb. nitrate of soda per acre.

D. 63 lb. N as 404 lb. nitrate of lime per acre.

E. 242 lb. agricultural lime.

F. as B + E.

G. as C + E.

As nitrate of lime has been found to be very deliquescent and difficult to store it was decided to replace this treatment by urea at 46.4 per cent N for the third cycle and for subsequent cycles.

The first cycle yielded a plant of an average weight of $3\frac{1}{4}$ lb. after nearly 19 months with 43.10 in. rain; the second cycle yielded plants of about $5\frac{1}{4}$ lb. after $20\frac{1}{2}$ months with 51.46 in. rain. In the first cycle the differences in the average weights per plant between the treatments were too small to be significant. In the second cycle the application of sulphate of ammonia produced a plant significantly better than those in the other treatments (average weight per plant just under $6\frac{1}{4}$ lb.). The plants from the untreated plots with an average weight of just under 6 lb. were heavier than those from any of the remaining treatments and there is an indication from the figures obtained that agricultural lime inhibits growth slightly on these soils whether applied alone or in combination with nitrogenous fertilizers.

NURSERY FERTILIZER AND IRRIGATION TRIAL

Object.—To ascertain whether growth rate when applying sisal waste and/or nitrogen can be speeded up by irrigation so the time in the nursery is reduced from 18 months to 12 months.

Date of commencement.—1st November, 1956.

Spacing.—2 ft. $\times$ 9 in. (29,040 plants per acre).

Design.— 2^3 factorial partially confounded.

Treatments.—

Thirty tons of sisal waste per acre as a mulch.

Fifty lb. of N in the form of 105 lb. urea per acre three weeks after planting followed by 50 lb. of N as urea six months after planting.

Irrigation to make up rainfall to approximately 45 in. per year.

Planting date.—10th November, 1956.

The trial is growing well and due to the generous rains since planting no irrigation has been necessary. The trial is too young to comment on.

Planting Material Trials

PLANTING METHOD TRIAL

Object.—To compare yields when using graded old suckers from overgrown fields, graded young suckers from two-year-old fields and graded nursery plants produced from bulbils.

Date of commencement.—24th April, 1949.

Spacing.—12 ft. $\times$ 2 ft. 6 in. (1,452 plants per acre).

Treatments

Planting Material

Old suckers 19 in. high, weighing 6 lb.

Young suckers 15 in. high, weighing $1\frac{1}{2}$ lb.

Nursery plants 18 in. high, weighing 4–5 lb.

Depth of Planting

Deep

7 in. deep for young suckers.

9 in. deep for old suckers and nursery plants.

Shallow.—Approximately 3 in. deep for all three planting materials.

Design.—6×6 Latin square.

The results to date of this trial can be expressed as follows, based on growth recording in November, 1956, and the cut in January, 1956:—

	SHALLOW PLANTED			DEEP PLANTED		
	Nursery plants	Young suckers	Old suckers	Nursery plants	Young suckers	Old suckers
Leaf count	225	232	223	218	224	214
Leaf length in inches ..	41·6	40·1	40·4	40·4	39·3	40·2
No. of leaves cut per plant	178	159	175	164	151	168
Fibre per acre in tons ..	4·99	4·03	4·73	4·29	3·71	4·40
Thousand leaves per ton fibre	52·2	59·1	54·2	56·3	61·3	56·5
Poling per cent	73%	41%	70%	48%	30%	58%

This trial is now so old that the results are showing clear indications.

The bigger planting materials have reached the first cut in a shorter period since planting and have generally yielded results quicker than in the case of plants which were small at planting.

The difference between the old suckers and nursery plants is negligible, which would indicate that well graded suckers can be used as planting material with good results. That the emphasis is on "well graded" must be appreciated. Suckers which have been gathered indiscriminately and planted out can only lead to uneven fields.

The preference must always be for nursery plants, for it is cheaper to lift an even stand of plants from the nursery than it is to collect suckers from old fields; sometimes other factors become involved which make sucker collection desirable and even economical.

The disadvantage of deep planting is demonstrated in all three planting materials in the smaller number of leaves cut per plant, fewer tons of fibre per acre, and in the larger number of leaves needed per ton of fibre. The last factor is especially clear in the first cut where the deep planted needed about 10,000 leaves more per ton of fibre produced.

The greater part of the trial was given a pole-cut in June, 1955, to prevent loss of leaves, and excluding this cut the trial has had five regular cuts with yearly intervals. The average number of leaves needed to date per ton of fibre is given in the table above but may be further detailed as follows (in thousands):—

	NURSERY PLANTS		YOUNG SUCKERS		OLD SUCKERS	
	Shallow	Deep	Shallow	Deep	Shallow	Deep
1st cut	110·2	119·5	135·1	145·9	114·8	123·2
2nd cut	65·2	67·4	83·6	80·8	67·1	65·3
3rd cut	46·6	50·2	52·7	52·7	47·2	47·2
4th cut	36·5	39·3	39·9	41·0	37·7	38·3
5th cut	40·5	41·1	42·9	42·7	43·2	41·9

It will be seen that the biggest difference between shallow and deep plantings was found in the first cut. Leaves from poling plants were included in the fifth cut and as the last leaves produced on a plant just before poling are shorter than those grown previously a greater number of leaves was needed per ton of fibre for this cut than was needed for the fourth cut.

The rate of leaf production throughout the seven years this trial has been in the ground has not varied much between the different treatments when taken year by year, the differences between shallow and deep planted material were most pronounced during the first two years of growth.

The average number of leaves grown per plant during the first seven years of the three different planting materials can be expressed as follows:—

				Nursery plants	Young suckers	Old suckers
1st year	..	..	..	35.8	31.3	33.3
2nd year	..	..	..	44.6	44.8	45.5
3rd year	..	..	..	41.6	44.1	43.2
4th year	..	..	..	33.8	34.4	35.1
5th year	..	..	..	27.1	26.7	27.0
6th year	..	..	..	23.9	25.6	21.4
7th year	..	..	..	12.0	16.9	10.9

The reduced rate of growth during the seventh year is partially caused by the influence of poling which brings the average of all the plants down due to some of the plants ceasing to produce any leaves at all.

The drop in leaf production as the plant grows older warrants further investigation.

PLANTING MATERIAL TRIAL

Object.—To investigate the possibility of obtaining greater efficiency by using larger nursery plants and to investigate the effect of an earlier first cut than is normal practice in Kenya.

Date of commencement.—3rd November, 1950.

Spacing.—13 ft. × 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments

Planting Material

Nursery plants 9 in. high, weight about 1 lb.

Nursery plants 15 in. high, weight about 3–3½ lb.

Nursery plants 21 in. high, weight about 6½–7 lb.

Development at First Cut

Early: 80–90 leaves produced since planting.

Normal: 100–110 leaves produced since planting.

Late: 120–130 leaves produced since planting.

Intensity of Cut

Heavy: Leaving 25 leaves after first cut and
20 leaves after subsequent cuts.

Medium: Leaving 35 leaves after first cut and
30 leaves after each subsequent cut.

Light: Leaving 45 leaves after first cut and
40 leaves after each subsequent cut.

The number of leaves grown per plant until November, 1956, did not vary much between the three types of planting material being 189 ± 4 while the variations in length were equally small being $41\frac{1}{2} \pm 1\frac{1}{4}$ in.

The trial was given a fourth cut in May, 1956, which gave the following results:—

	Total No. of leaves cut per plant	Total wt. of leaves cut lb.	Mean wt. of leaves cut lb.	Total wt. of fibre per acre tons	Poling
Planting Material:					
9 in.	107	136	1.27	3.30	4.9%
15 in.	106	129	1.21	3.25	5.6%
21 in.	123	170	1.38	4.34	14.9%
1st cut at:					
80-90 leaves ..	118	147	1.25	3.89	6.9%
100-110 leaves ..	110	137	1.24	3.38	5.9%
120-130 leaves ..	107	151	1.41	3.63	12.5%
Cutting Intensity:					
Leaving 25 leaves..	122	162	1.33	4.11	9.0%
Leaving 35 leaves..	114	154	1.35	3.87	10.8%
Leaving 45 leaves..	99	119	1.20	2.91	5.6%

The difference in number of leaves needed per ton of line fibre can best be seen when expressed in thousands cut by cut:

	1st cut	2nd cut	3rd cut	4th cut	Average
Planting Material:					
9 in.	138.0	86.6	59.6	47.1	71.3
15 in.	147.5	80.3	55.6	47.8	69.3
21 in.	125.8	66.0	47.0	41.3	59.5
1st cut at:					
80-90 leaves ..	171.0	92.7	55.9	43.9	66.5
100-110 leaves ..	134.8	73.0	54.3	46.6	69.0
120-130 leaves ..	105.5	67.2	52.0	45.8	64.7
Cutting Intensity:					
Leaving 25 leaves..	128.3	70.0	48.8	43.6	63.5
Leaving 35 leaves..	139.6	77.2	51.9	42.8	64.4
Leaving 45 leaves..	143.4	85.7	61.5	49.8	72.2

It is clear that the biggest planting material came into cutting earlier and has consistently given a more economic cut when compared with the plants which were smaller when planted out from the nursery: the figures must also be seen in conjunction with the fibre yield and poling percentage figures.

Although the earliest first cut has up to now produced a greater amount of line fibre and although the average number of leaves needed per ton of fibre throughout the four cuts does not vary much, the differences in the number of leaves needed per ton in the first two cuts is of economic importance. It is possible therefore that it would be more economical to sacrifice the increased tonnage and get a smaller tonnage needing less leaves to produce a ton of fibre.

The differences due to the cutting treatments are great, although not as great as those in the various first cuts. Comment is withheld until poling has influenced the cuts to a greater extent than is visible to-day. The importance of the uncut leaves left in the fields by the more lenient cuts must be borne in mind.

Plant Management Trials

The object of the following five trials is to ascertain variations in growth rates in various districts of Kenya using different spacing and cutting treatments. Treatments for spacings are as follows, with the figures in the body of the table giving the distance between plants in the row.

Plant Populations per acre:				1200		1600		2000	
Row spacing:	14'	×	31"	×	23"	×	18"		
Row spacing:	11'	×	39"	×	29"	×	23"		
Row spacing:	18'	×	3'	×	41"	×	31"	×	24"

Development at First Cut:

100 leaves grown since planting.

125 leaves grown since planting.

150 leaves grown since planting.

Severity of cutting:

Light: Leaving 30 leaves after each cut.

Medium: Leaving 20 leaves after each cut.

Heavy: Leaving 10 leaves after each cut.

Design: 3^4 factorial arranged as a 9×9 Quasin Latin square.

The differences needed between two figures to be significant are expressed on two probability levels of 95 per cent and 99 per cent at the bottom of each column as $P=0.05$ and $P=0.01$, while each column represents one of the subjects under investigation.

RUIRU TRIAL (BLACK COTTON SOIL) RIDGED

Locality.—Juja Farm, Ruiru.

Date of commencement.—16th March, 1948.

The summary of the last recordings for leaf count and leaf length in July, 1956, and after the last cut in February, 1956, is as follows:—

	Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
		<i>in.</i>					
Spacing—							
14 ft.	178	38.2	101	111	2.65	65.0	26.7
11 ft.	184	38.5	104	114	2.81	63.8	32.0
18 ft. × 3 ft. ..	187	39.8	109	126	3.03	62.2	37.7
Population—							
1,200 plants per acre..	199	41.6	127	154	2.92	53.9	60.3
1,600 plants per acre..	181	37.5	100	107	2.69	65.0	22.6
2,000 plants per acre..	169	37.4	88	91	2.88	72.1	13.6
First Cut at—							
100 leaves	190	38.1	125	132	3.42	64.0	26.2
125 leaves	182	38.1	109	120	2.75	67.0	31.2
150 leaves	176	40.3	81	100	2.32	60.1	39.0
Cutting—							
Light: leaving 30 leaves	183	39.0	101	115	2.85	64.3	34.3
Medium: leaving 20 leaves	183	39.8	105	122	2.86	62.7	36.6
Heavy: leaving 10 leaves	183	37.8	109	115	2.79	64.0	25.5
Difference required for significance—							
P=0.05	7	2.2	13	22	0.65	6.7	15.5
P=0.01	9	3.0	18	30	0.87	9.1	20.9

The variations in the results from the different row spacings and cutting intensities are not big enough to be significant in any of the subjects under observation. The variations between the figures for population per acre show that the rate of leaf production in the individual plants is closely related to the number of plants per acre, which again is reflected in the number of leaves cut off per plant. The population per acre multiplied by number of leaves cut off per plant gives the number of leaves harvested per acre as: 152,400; 160,000 and 176,000; hence the small and insignificant variations in the figures for tons of fibre per acre. The poling percentage figures clearly indicate that a greater amount of life is left in the higher populations so that the differences in yields of fibre may be enlarged when the trial gets nearer to poling out.

It would appear that a delayed first cut on these soils is a thing to be avoided. The early first cut has not reduced the leaf length to any appreciable extent while the late first cut has produced leaves at a slower rate. The average weight of leaves cut is 1.06, 1.10 and 1.23 lb. respectively which is reflected in differences for the number of leaves needed per ton of fibre. These differences are not significant, but the linear trend of the fibre yield figures is so marked that an early first cut on these soils is obviously to be recommended, bearing in mind that a plant with 100 leaves grown after it was planted out in the field is a well developed plant of about 5 ft. height over the centre.

TRANS NZOIA TRIAL

Locality.—Ziwa Limited, Hoey's Bridge.

Date of commencement.—10th April, 1948.

The summary of recording for leaf growth and cutting results up to October, 1956, is as follows:—

	Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
		<i>in.</i>					
Spacing—							
14 ft.	246	43.1	167	227	5.14	53.3	26.5
11 ft.	258	43.5	186	258	6.11	49.6	47.0
18 ft. × 3 ft. ..	248	42.4	174	231	5.39	52.0	37.8
Population—							
1,200 plants per acre..	267	43.3	196	285	5.21	47.0	64.8
1,600 plants per acre..	251	43.1	178	242	5.86	50.4	36.7
2,000 plants per acre..	235	42.5	152	189	5.58	57.5	9.8
First cut at—							
100 leaves	250	42.1	176	226	5.46	53.4	33.3
125 leaves	250	42.3	175	233	5.29	53.6	31.9
150 leaves	252	44.5	175	257	5.90	48.0	46.0
Cutting—							
Light: leaving 30 leaves	253	45.6	177	249	5.81	49.0	59.7
Medium: leaving 20 leaves	252	43.8	173	244	5.70	50.2	39.6
Heavy: leaving 10 leaves	248	39.5	177	223	5.13	55.7	11.9
Difference required for sig- nificance—							
P=0.05	3	0.8	7	12	0.35	1.9	10.5
P=0.01	4	1.1	10	16	0.47	2.5	14.1

The most significant result from this trial is a clear demonstration of the ability of the land to carry a population of 2,000 plants per acre and to give a higher yield over a longer cycle in spite of the slower growth of the individual plants.

The earliness of the first cut has not influenced the number of leaves produced per plant, but the state of the leaves is clearly seen if the mean weight per leaf is obtained by dividing the number of leaves cut into the weight of the leaves cut when the relation is 1.28, 1.33 and 1.47 lb. per leaf, the heaviest leaf is got from the later first cuts which explains the higher tonnage of fibre and smaller number of leaves per ton of fibre. The reduction in leaf length caused by an early first cut is a warning which is brought home even more forcefully in the treatments for cutting intensity. In this treatment it is clear that leaving less than 30 leaves per plant after each cut will yield a lighter leaf, lower tonnage of fibre and will need an appreciably greater number of leaves per ton of fibre, and although the heavy cutting may delay poling and prolong the cycle this is achieved at the cost of greater expense in production.

KAMPI-YA-MOTO TRIAL

Locality.—Alphega Sisal Estate, Kampi-ya-Moto.

Date of commencement.—23rd October, 1948.

A summary of the results obtained from recording of growth rates and cutting in October, 1956, is given as follows:—

	Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
		<i>in.</i>					
Spacing—							
14 ft.	193	41.6	132	160	3.58	64.1	50.3
11 ft.	201	42.0	139	172	3.87	60.6	62.1
18 ft. × 3 ft. ..	188	37.9	122	129	2.89	73.6	32.6
Population—							
1,200 plants per acre..	205	42.2	146	183	3.13	60.0	70.9
1,600 plants per acre..	196	40.7	135	159	3.66	63.6	52.2
2,000 plants per acre..	181	38.7	111	120	3.49	74.6	21.9
First cut at—							
100 leaves	194	39.5	139	152	3.51	67.4	44.8
125 leaves	196	40.9	136	161	3.66	63.4	52.3
150 leaves	192	41.1	117	148	3.11	67.4	48.0
Cutting—							
Light: leaving 30 leaves	194	41.4	126	149	3.39	64.1	54.6
Medium: leaving 20 leaves	192	40.4	130	152	3.37	68.4	51.4
Heavy: leaving 10 leaves	195	39.4	137	159	3.52	65.8	39.0
Difference required for significance—							
P=0.05	5	1.9	8	16	0.43	7.3	12.7
P=0.01	7	2.5	11	22	0.58	9.9	17.1

This trial grows on a piece of poor and rather uneven soil which is below the fertility of the surrounding country and the figures obtained may indicate that a population of 1,600 plants per acre is about the maximum on this soil, but a population of 2,000 plants per acre on the areas of higher fertility would not appear to be too much. The higher population can be expected to induce a slower growth for the individual plant, and a delayed poling, but as the tonnage of fibre per acre is not reduced this is not a disadvantage. The higher number of leaves needed per ton of fibre will need closer observation; they should be compared with differences between the poling figures when they are smaller than they are today.

The effect of the first cut is seen in the average weights of leaves cut which are 1.09, 1.18 and 1.26 respectively. The lower yield of fibre from the delayed first cut at 150 leaves is accounted for by a loss of about 15 leaves over 2 ft. long per plant before the cut was taken.

The cutting intensity has not influenced the number of leaves produced per plant and although the differences in leaf length are not significant the linear effect is clear and indicates that a heavier cut can reduce the length of the leaves. That the heaviest cut has produced most fibre to date is obvious as more leaves have been cut off per plant and as this also retards the time of poling. comment is reserved till the trial gets closer to its final cut.

THIKA TRIAL (RED SOIL)

Locality.—Anglo-French Estate, Thika.

Date of commencement.—17th November, 1948.

The summary of the results obtained from recording of plant growth in September, 1956, and including figures from a pole cut in September, 1956, is given as follows:—

	Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
		<i>in.</i>					
Spacing—							
14 ft.	216	43.0	148	201	4.58	53.1	32.2
11 ft.	234	43.7	172	246	5.84	47.7	55.1
18 ft. × 3 ft. ..	219	41.9	147	192	4.45	53.7	31.4
Population—							
1,200 plants per acre..	241	43.3	179	258	4.67	47.5	64.2
1,600 plants per acre..	225	42.6	156	211	5.11	50.6	33.6
2,000 plants per acre..	205	42.7	132	171	5.10	56.4	20.9
First cut at—							
100 leaves	226	42.3	169	208	5.09	54.7	38.0
125 leaves	225	42.1	163	221	5.10	53.0	35.7
150 leaves	219	44.2	135	211	4.69	46.8	44.9
Cutting—							
Light: leaving 30 leaves	222	44.4	154	218	5.03	50.6	57.6
Medium: leaving 20 leaves	221	43.2	150	203	4.71	51.7	33.1
Heavy: leaving 10 leaves	226	41.0	163	219	5.14	52.2	28.0
Difference required for significance—							
P=0.05	4	0.9	5	14	0.38	2.2	10.6
P=0.01	5	1.2	7	19	0.52	3.0	14.2

Although the individual plant growth is obviously slower in the higher populations as expressed in the smaller number of leaves per plant, the tonnage obtained so far and the poling percentage clearly indicate the advantage of a high population per acre. The higher number of leaves needed per ton of fibre is not of great importance when it is remembered that the leaves come from plants which in development are 16 and 36 leaves behind the lowest population.

The disadvantage of a too early first cut is seen in weight of leaves cut which on an average are 1.23, 1.36 and 1.57 lb. per leaf respectively for the three levels of first cut. This in turn explains the smaller number of leaves needed per ton of fibre when the first cut is delayed. The differences in weight of fibre are too small to be significant as are the differences in poling percentage in the figures relating to different first cuts.

The different cutting intensities give an indication that the leaves tend to shorten when cutting is too heavy, but they also indicate that poling is retarded by a heavy cut. Whether the latter is going to be beneficial remains to be seen and it must wait till the poling is more general.

KIBWEZI TRIAL

Locality.—Dwa Plantations Limited, Kibwezi.

Date of commencement.—21st October, 1949.

The summary of recording for leaf growth in August, 1956, and of cutting including a pole cut taken in August, 1956, is as follows:—

	Total leaf count	Average length of last leaf grown	Av. No. of leaves cut per plant	Av. wt. in lb. of leaves cut per plant	Calc. tons of fibre per acre	Calc. No. of leaves in thousands per ton of fibre per acre	Poling per cent
		<i>in.</i>					
Spacing—							
14 ft.	179	47.1	124	161	4.37	45.5	60.2
11 ft.	187	48.0	136	183	5.06	43.6	79.5
18 ft. × 3 ft. ..	183	47.4	124	159	4.39	45.6	62.3
Population—							
1,200 plants per acre..	193	49.3	146	201	4.21	42.2	87.2
1,600 plants per acre..	184	47.2	127	166	4.67	44.9	73.0
2,000 plants per acre..	172	45.9	111	136	4.95	47.6	41.9
First cut at—							
100 leaves	186	44.8	139	161	4.67	47.9	50.0
125 leaves	183	47.3	134	175	4.76	45.2	68.1
150 leaves	180	50.3	112	167	4.39	41.6	84.0
Cutting—							
Light: leaving 30 leaves	185	49.3	134	178	4.97	43.3	80.5
Medium: leaving 20 leaves	182	47.1	125	161	4.43	45.4	66.3
Heavy: leaving 10 leaves	182	46.1	126	164	4.43	46.1	55.2
Difference required for sig- nificance—							
P=0.05	3	1.2	4	13	0.39	1.9	7.4
P=0.01	5	1.6	6	17	0.53	2.5	10.0

The population figures indicate the advantage of a high population per acre, the tonnage taken off is higher and the poling percentage is lower than for the low population. The average weight of leaves cut in the three populations varies at present from 1.37; 1.30 to 1.22 lb. per leaf and explains the higher number of leaves needed per ton in the higher populations. It must, however, be borne in mind that the lowest population is nine and 21 leaves ahead in its development when compared to the other two populations and although it is likely that the lowest population will continue to grow a leaf longer than the other populations it is unlikely that this will compensate for the increased fibre yield and longer cycle in the higher populations.

The danger of a first cut taken too early is seen in the shortening of the leaves which, in this case, is related to plants of similar development with equal leaf count. The total yields will have to be known before the final results can be obtained, but as the plots are being cut out when reaching a poling percentage of 80 per cent or more it is likely that the earliest first cut will produce a greater amount of fibre although it is equally clear that more leaves will be needed to produce one ton of fibre than when the first cut was taken later. The figures must be obtained to finality before one can discover if the biggest yield is also giving the highest economic net return per acre.

The intensity of cutting has not interfered with the number of leaves produced per plant but has definitely influenced the leaf length. The greater number of leaves cut off per plant in the most lenient treatment is a result of earlier poling and also explains the increased fibre yield.

SUMMARY OF THE PRECEDING FIVE TRIALS

It may be of interest to compare the growth rate year by year for the five external spacing and cutting trials, for which the analysis of the average number of leaves produced per plant looks as follows:—

Average No. of leaves grown per plant	Ruiru Black Cotton	Trans Nzoia	Kampi- ya- Moto	Thika Red Soil	Kibwezi
First six months ..	2.0	4.8	4.2	2.8	5.5
Next year	28.1	31.0	32.8	32.7	31.2
Next year	37.0	41.7	36.2	43.9	50.7
Next year	36.0	44.2	32.8	40.9	31.7
Next year	24.1	38.3	24.9	31.9	26.9
Next year	19.3	32.0	19.1	25.6	25.8
Next year	15.0	20.8	18.9	22.3	10.1
Next year	12.6	21.9	18.9	18.0	—
Next year	8.8	15.9	—	—	—
Total	182.8	250.6	187.8	218.1	181.9

Poling has in all cases influenced the average number of leaves grown per plant during the last year or two.

The drop in annual leaf production per plant as the plants get older would appear to be universal and further investigation would be desirable.

For Kampi-ya-Moto and Thika, a further half yearly recording has been included in the leaf counts which are published earlier in this report, hence the difference in the average number of leaves per plant.

DOUBLE- versus SINGLE-ROW TRIAL

Object.—To compare various plant populations and row spacings, and to establish whether a certain plant population will perform equally well whether planted in single row or in double rows, when the distance between the rows is the same.

Date of commencement.—15th April, 1952.

*Treatments**Populations*

1,600 plants per acre.

2,000 plants per acre.

2,400 plants per acre.

Distance between rows

11 ft.

13 ft.

Row spacing

Double rows 3 ft. between rows.

Single rows.

Design.— $3 \times 2 \times 2$ partially confounded.

At the recording in October, 1956, the results are as follows for leaf count and leaf length:—

1,600 plants per acre	154 leaves per plant, last leaf 46.9 in.
2,000 plants per acre	143 leaves per plant, last leaf 49.0 in.
2,400 plants per acre	134 leaves per plant, last leaf 50.1 in.
Row spacing 11 ft.	147 leaves per plant, last leaf 48.5 in.
Row spacing 13 ft.	141 leaves per plant, last leaf 48.8 in.
Double row	141 leaves per plant, last leaf 49.4 in.
Single row	128 leaves per plant, last leaf 50.8 in.

The longer leaf produced by the higher populations must be attributed to the drawing effect of plants growing close together on high fertility virgin soil.

Cutting.—Some of the plots have had two cuts while a few have yet to have their first cut which in all plots takes place when the plants have produced between 120 and 130 leaves since planting.

The speed of growth may be seen in the number of plots given a first cut at the various dates.

	PLANTS PER ACRE			ROW SPACING		LINES	
	1,600	2,000	2,400	11 ft.	13 ft.	Double	Single
Cut May, 1955 ..	6	—	—	4	2	5	1
Cut December, 1955 ..	6	7	6	9	10	10	9
Cut May, 1956 ..	—	5	3	4	4	3	5
Remains to be cut ..	—	—	3	1	2	—	3
	12	12	12	18	18	18	18

It will be seen that in the higher populations the rate of the individual leaf production is slower, which is to be expected, and is due to interplant competition. There has been very little, if any, influence on the development of individual plants due to the row spacing but the double row has induced a speedier growth compared to the single row especially in the higher populations and it is noticeable that the three plots remaining uncut are single rows with populations of 2,400 plants per acre. This would indicate that double rows are essential if all other factors justify a high population of 2,000 plants per acre or more.

The yields per acre to date are as follows:—

1,600 plants per acre 1.29 tons (six out of 12 plots cut twice).

2,000 plants per acre 0.91 tons (all 12 plots cut once).

2,400 plants per acre 1.02 tons (nine plots cut once, three plots uncut).

11 ft. 1.20 tons (four out of 17 plots cut twice, one plot uncut).

13 ft. 0.95 tons (two out of 16 plots cut once, two plots uncut).

Double rows 1.18 tons (five plots cut twice, 13 plots cut once).

Single rows 0.96 tons (one plot cut twice, 14 plots cut once, three plots uncut).

These figures only give the picture as it is to date and as all the plots are not yet cut, the figures must be treated with caution.

The variations between single and double rows, which this trial sets out to measure, are probably best seen in the number of leaves produced per plant and can be expressed as follows:—

Plants per acre	3 ft. double rows 11 ft. apart	Single rows 11 ft. apart	3 ft. double rows 13 ft. apart	Single rows 13 ft. apart
1,600 plants ..	162	153	155	146
2,000 plants ..	147	140	146	138
2,400 plants ..	146	131	136	124

Plants in the double rows have always grown faster whatever the distance between the rows. It is also of interest to note that the drop in leaf production as the plant population increases is bigger in the single rows than in the double rows, which would indicate that double rows cannot be ignored if high populations are to be aimed at.

Cultivation Trials

CULTIVATION TRIAL

Object.—To investigate the effect on the soil and sisal plants of continuous clean weeding by mechanical means as against restricted weeding with and without a controlled grass cover in the area between sisal lines.

Date of commencement.—1st November, 1950.

Spacing.—13 ft. + 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments

- (1) Grass strip slashed frequently to keep grass low.
- (2) Grass strip cut periodically and the cut grass used as mulch round sisal plants.
- (3) Clean weeded by frequent discing for the first three years, then as (2).
- (4) Clean weeded by frequent discing for the first three years, then discing twice a year.
- (5) Discing twice a year for the whole cycle.
- (6) Clean weeding by frequent discing for the whole cycle.

This trial incorporates the above treatments with sisal planted on the flat and on ridges. The grass cover is obtained by sowing Rhodes grass *Chloris gayana* in 6-ft. wide strips between the double rows.

Design.—Rectangular lattice square with four replications.

The initial fertility in this area was very high and may account for the small variations between the different cultural treatments. These variations are only becoming apparent after six years, but are expected to be more pronounced in the following cycles when fertility decreases.

The plots which have been clean weeded throughout the cycle have produced about ten leaves more per plant than the plots where grass was introduced from the beginning or after three years. As the average leaf count for the trial is about 213 leaves per plant, this variation is not very great and should not influence the duration of the trial to any great extent in the first cycle.

The effect of ridging on this red soil has been small and only amounted to an increase of about two-three leaves per plant, which is not significant.

The average yield of fibre obtained per acre is now in the region of 5.39 tons per acre which is exceptionally good and must be attributed to the high fertility of the soil with the consequent rapid growth of long leaves. Two treatments on ridged soil which have been kept clean since planting have exceeded six tons of unbrushed fibre per acre, but the differences so far in the first cycle do not justify too much comment as the greater variations are expected only after the land has been under sisal for a considerably longer time.

INTERPLANTING (PINE-APPLES) TRIAL

Object.—To investigate whether an interplanted crop and ratoon crop of pineapples taking three years will affect the growth of sisal during the unproductive period till first cut, and to ascertain whether the heavy applications of nitrogenous fertilizers given to the pine-apples will benefit the sisal.

Date of commencement.—27th September, 1956.

Spacing.—15 ft. + 3 ft. $\times$ 2 ft. 9 in. (1,760 plants per acre) to enable a double row of pineapples to be planted 3 ft. on either side of the double row of sisal, on cambered beds 18 ft. wide.

Treatments

Sisal alone.

Sisal with pineapples interplanted.

Sisal alone receiving nitrogenous fertilizers.

Sisal with pineapples interplanted receiving nitrogenous fertilizers.

Design.—2² with five replications.

The trial is too young for critical comment but both sisal and pineapples are growing well.

Fertilizer and Manurial Trials

FERTILIZER TRIAL

Object.—To investigate the effect on the growth rate of sisal plants of applying artificial fertilizers and/or sisal waste.

Date of commencement.—16th March, 1950.

Spacing.—13 ft. + 3 ft. $\times$ 2 ft. 9 in. (1,980 plants per acre).

Treatments

Ca=Agricultural lime (96 per cent CaCO_3), broadcast over the whole treated area at the rate of 2.0 tons per acre a month before planting.

W=Sisal waste as fresh sisal waste taken straight from a Corona decorticator, decorticating dry. The waste was applied at the rate of 107 tons wet waste per acre and dug in one month before planting in strips covering an area 4 ft. each side of the double rows.

N=Sulphate of ammonia applied at the rate of 388 lb. per acre in each of the first four years of the cycle.

P=Double superphosphate, applied in shallow trenches under the plants a week before planting at the rate of 260 lb. per acre. (As the effect was quick but only lasted for about 18 months an extra application at the rate of 150 lb. double superphosphates was given after three years.)

K=Muriate of potash, applied at the rate of 395 lb. per acre for the first year and 300 lb. per acre during each of the next three years.

Design.— 2^5 factorial.

At the recording for leaf count in October, 1956, the effects of Ca, P and K were again non-significant with Ca and P having produced over 204 leaves against 200 leaves for the plots not receiving these fertilizers. The same two figures were reversed in the K applications, indicating a slight but insignificant reduction in number of leaves when K was applied.

Sisal waste and Nitrogen are still the only two fertilizers to show any significant effect, with about 20 and 13 more leaves per plant respectively than plants not receiving these fertilizers.

It may be of interest to see when these extra leaves were actually produced, using the P application as a comparison:—

	Waste	Nitrogen	P
Increase during the first six months after planting	+2.19	+0.72	2.44
The following year (1951)	+7.39	+2.20	2.90
The following year (1952)	+3.55	+1.46	-0.39
The following year (1953)	+2.05	+2.21	0.16
The following year (1954)	+2.41	+2.96	0.09
The following year (1955)	+2.83	+2.83	-0.67
The following year (1956)	-0.10	+0.33	-0.07
Total increase in leaf count ..	+20.32	+12.76	4.46

The mean numbers of leaves produced per plant per year in this trial are:—

Leaves grown the first six months ..	11.4 average per month	1.9
The following year 1951	49.2 average per month	4.1
The following year 1952	46.5 average per month	3.9
The following year 1953	32.0 average per month	2.7
The following year 1954	26.1 average per month	2.2
The following year 1955	21.7 average per month	1.8
The following year 1956	15.8 average per month	1.3

Average No. of leaves per plant ..	202.7 average per month	2.6
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over $6\frac{1}{2}$ years.

The fall-off in annual leaf production does not appear to be caused by poling only, as the poling percentages are low with about 13 per cent for Ca, P and K, about 17 per cent for N and 21 per cent for waste.

The trial was given a fourth cut in January, 1956, and only the waste and Nitrogen plots have produced significantly larger amounts of fibre. This is an obvious conclusion, for those with more leaves produced per plant will have had a correspondingly bigger number of leaves cut, and although the yields may possibly be the same for all treatments when they come to finality, the time taken may be longer for the treatments showing a little or no response to date.

A factor of considerable economic interest is the number of leaves needed per ton of fibre, and here again the waste and Nitrogen plots show the greatest differences which, cut for cut, can be expressed as follows:—

	1st cut	2nd cut	3rd cut	4th cut	Total mean
With waste—					
No. of leaves cut per plant ..	39	33	25	29	126
Tons of fibre per acre ..	0.60	0.97	0.99	1.42	3.98
Leaves per ton of fibre in thousands	129.4	70.2	50.8	40.9	64.5
Without waste—					
No. of leaves cut per plant ..	34	22	21	20	97
Tons of fibre per acre ..	0.53	0.56	0.67	0.81	2.57
Leaves per ton of fibre in thousands	127.7	83.8	64.0	52.0	77.9
With nitrogen—					
No. of leaves cut per plant ..	37	31	24	29	121
Tons of fibre per acre ..	0.57	0.87	0.91	1.31	3.66
Leaves per ton of fibre in thousands	129.0	74.9	56.1	44.2	68.6
Without nitrogen—					
No. of leaves cut per plant ..	36	24	22	20	102
Tons of fibre per acre ..	0.55	0.67	0.75	0.93	2.90
Leaves per ton of fibre in thousands	128.1	79.0	58.7	48.7	73.8

It is clear that with the exception of the first cut the treated plots not only give more fibre per cut but also the cuts are more economic as fewer leaves are needed to produce a ton of fibre. Even if the untreated plots should, over a longer cycle, produce the same amounts of fibre, the savings on the first four cuts will always be an economy.

SISAL WASTE AND MINERALS TRIAL

Object.—To compare the effect of different methods of applying fresh sisal waste, sisal waste reinforced with artificial fertilizers and artificial fertilizers alone.

Date of commencement.—17th March, 1950.

Treatments

	Fresh sisal waste	Sulphate of ammonia	Double super- phosphate	Muriate of potash	Agric. lime (Ca CO ₃ 96%)
	<i>tons</i>	<i>lb.</i>	<i>lb.</i>	<i>lb.</i>	<i>tons</i>
A.—Control	Nil	Nil	Nil	Nil	Nil
B.—Waste half dug in and half as mulch	107	Nil	Nil	Nil	Nil
C.—Waste dug in ..	107	Nil	Nil	Nil	Nil
D.—Waste all as mulch	107	Nil	Nil	Nil	Nil
E.—Waste half dug in and half as mulch with minerals added	107	390	65	325	0.42
F.—Waste dug in with minerals added ..	107	390	65	325	0.42
G.—Waste all as mulch with minerals added	107	390	65	325	0.42
H.—Minerals only ..	Nil	1,560	260	1,300	2.0

The waste, lime and superphosphate were applied before planting as in the fertilizer trial. Sulphate of ammonia applied with waste at the rate of 129 lb. per acre for the first year and 87 lb. per acre during each of the next three years; applied without waste at the rate of 522 lb. for the first year and 346 lb. per acre during each of the next three years.

Muriate of potash applied with waste at the rate of 130 lb. per acre the first year and 65 lb. during each of the next three years; applied without waste at the rate of 520 lb. per acre for the first year and 260 lb. during each of the next three years.

Design.—Four randomized blocks of eight plots.

The following figures were obtained from the recording for growth in October, 1956, and from the annual cutting in January, 1956:—

	Control	Waste only				Waste and Artificials			Minerals only	P= 0.05	P= 0.01
	A.	B.	C.	D.	E.	F.	G.	H.			
Leaf count ..	194	204	206	208	216	215	211	209	19	26	
Leaf length, inches	38.0	37.6	37.4	37.8	42.7	38.5	39.1	37.4	5.6	7.7	
Av. No. of leaves cut per plant ..	80	89	88	90	103	101	98	93	14	19	
Av. wt. of leaves cut per plant ..	86	92	92	96	127	116	111	105	28	38	
Tons of fibre per acre ..	1.93	2.20	2.20	2.29	2.88	2.69	2.57	2.47	0.61	0.83	
No. of leaves in thousands per ton fibre ..	89.3	81.0	81.1	78.9	72.5	74.8	75.7	76.2	10.5	14.3	

Statistically significant differences have not been obtained between the various treatments in any of the subjects under investigation, partly due to soil variations within the trial area.

The rate of leaf production per plant follows closely the rates obtained in the Fertilizer Trial and it is clear that any increase over the untreated plots takes place within the first 2½ years, after which the advantage is reduced to about one leaf extra per year per plant which, even with a population of 1,980 plants per acre, is negligible.

It would appear likely that, whatever one does at planting to improve the initial growth, it is effective for two–three years only, after which one has either got to be content with the initial boost given to the plant or take steps to repeat the original treatment or introduce other treatments to maintain the increased growth-rate.

It is unlikely that this trial will produce any more information of value.

ROTATION FERTILIZER TRIAL

Object.—To investigate the effect on sisal of resting the land under grass for a period of years between the cycles, with and without a grass cover during the cycle. These treatments are combined with fertilizer treatments on bare land and grass strips between the sisal rows.

Locality.—Anglo-French Sisal Estate, Thika.

Date of commencement.—1st December, 1952.

Treatments

1st Cycle	2nd Cycle
(1) Clean weeding by frequent discing throughout.	As first cycle.
(2) Plant grass strips, cut grass and mulch along sisal rows.	As first cycle (sisal replanted where grass strips were).
(3) Plant grass strips, cut grass and mulch along sisal rows.	Leave grass strips to cover land for three years; then replant sisal and treat as first cycle.
(4) Clean weeding by frequent discing throughout.	Three years grass ley as first cycle.

Superimposed on the above treatments are the following fertilizer treatments:—

Control, N, P, Ca, NP, NCa, PCa and NPCa.

Sulphate of ammonia (N).—200 lb. per acre for the first four years of the cycle.

Double superphosphate (P).—150 lb. per acre at planting.

Agricultural lime (Ca).—Two tons per acre just before planting.

Design.—Six randomized blocks of four plots each. Each plot split for N, P and Ca (24 plots of 96 split plots).

Spacing.—13 ft. + 3 ft × 2 ft. 9 in. (1,980 plants per acre).

The difference between the clean weeded plots and those in which grass has been introduced has become more pronounced during the year. The trial was planted in December, 1952, and after two years there was no difference in the leaf counts of the treatments. After three years the plants in the clean weeded plots had produced an average of 93 leaves and those in the plots with grass just under 89 leaves per plant, and this difference of just over four leaves was, during the following or fourth year, increased to more than 11 leaves, the clean weeded plots having produced 118 leaves and those with grass 107 leaves per plant.

(That competition by the grass becomes apparent only after two years has also been demonstrated in the Fertilizer, Waste and Grass Trial reported below.)

The responses to agricultural lime have been small and insignificant. Double superphosphate gave the plants an initial boost, the phosphate plots having produced after two years just under five leaves more than the untreated plots: this difference has, however, been reduced, during the following period, to under three. The response to the nitrogenous fertilizer applications was small and insignificant during the first two years, but later applications gave a small but consistent increase in the number of leaves and the response to date has been an increase from 111 to 114 leaves per plant.

In no case have the fertilizer treatments been able to off-set the retarding influence of the grass grown between the lines.

The trial is given a first cut when the average number of leaves per plant reaches about 120. Eight of 24 plots without grass were cut and only one out of 24 with a grass cover was cut during the year, and this was the biggest difference observed. The number of plots cut of the three fertilizer treatments varied from nine to 11 plots out of 48, and these figures are not sufficient to justify making a comparison of fibre yields.

FERTILIZER, WASTE AND GRASS TRIAL

Object.—To investigate the effect of N, P, Ca and sisal waste on old sisal land with and without grass strips introduced between the sisal lines.

Locality.—Anglo-French Sisal Estate, Thika.

Date of commencement.—3rd December, 1952.

Treatments.—The following applications were applied singly and in all possible combinations:—

W=*Sisal waste*: collected from a rotary pulp extractor and applied at the rate of 20 tons per acre in 6-ft. strips covering the planting lines.

N=*Sulphate of ammonia*: 200 lb. per acre applied close to the plants in April, 1953.

P=*Double superphosphate*: 150 lb. per acre applied as 108 lb. per acre at planting by dropping $\frac{7}{8}$ ounce under each plant. The balance applied in the centre of the wide space between the double rows in April, 1953.

Ca=*Agricultural lime*: at the rate of two tons per acre applied broadcast on 1st December, 1952.

G=*Grass*: Molasses grass *Melinis minutiflora* planted as strips between the sisal rows in April, 1953.

Spacing.—13 ft.+3 ft.×2 ft. 9 in. (1,980 plants per acre).

Design.—2⁵ factorial confounded.

This trial has produced several interesting features, and is one of the few trials where a response has been obtained from agricultural lime. Lime has increased the average leaf count from 113 on the untreated plots to 117 on the treated plots, of which the main increases took place during the first 18 months. After 2½ years the variations in growth rate between treated and untreated plots was not significant, so although the main stimulus took place in the short leaves the advantage has been retained till now. The Rotational Fertilizer Trial planted next to this trial shows no response to agricultural lime, so too much importance should not be attached to this effect.

The increase due to the small application of 20 tons of sisal waste is also rather startling and the recording in December, 1956, showed that the increase was from 110 leaves to 121 leaves per plant. From the growth graphs it is clear that the main part of this increase took place within the first two years, and that the plants, treated or untreated, produced more or less the same number of leaves after that. The advantage of the initial surge of growth however is now disclosed in the length of the last leaves on the plants, those on plots treated with sisal waste being on an average $4\frac{1}{2}$ in. longer.

The rates of leaf production per plant year by year may be of interest and for the sisal waste application are as follows:—

				Without sisal waste	With sisal waste	Difference
1st year	..	..	..	19.41	24.86	5.44
2nd year	..	..	..	36.65	41.36	4.71
3rd year	..	..	..	30.52	31.47	0.95
4th year	..	..	..	23.19	23.07	-0.12
				109.78	120.76	10.98

From the above figures it is quite clear that the increase in leaf count took place during the first two years.

The responses to sulphate of ammonia and double superphosphate have been negligible in this trial to date.

The effect of growing the grass between the lines is also becoming quite obvious, especially when a vigorous grass, such as Molasses grass has proved itself to be, is introduced. For the first two years the grass had no effect one way or the other on the growth of the plants but subsequently a regular decrease in leaf count and leaf length was recorded in the plots under grass; the grass reduced the leaf count from 120 to 111 and reduced the length of the leaves grown by about $3\frac{1}{2}$ in. The trial has not been weeded as often and as thoroughly as it might have been with such vigorous grass; normally, as on a farm, the grass would have been grazed down. It was felt that the treatment might be too lenient and not present the differences truthfully if a system of handweeding was adopted which was uneconomical in practice. The trial has given a clear warning about competition between grass covers and sisal when the root systems of the sisal have extended into the centre of the rows after two years of growth.

During the year the plots in this trial were first cut when the plants had reached an average leaf count of 120. Of the 16 plots with sisal waste 12 were cut, with N, P and Ca only eight out of 16 were cut and of the 16 plots having a cover of grass only four were cut. Too little information is yet available from the cutting upon which to make any comment.

EXPLORATORY FERTILIZER TRIAL, KIBWEZI

Object.—To investigate the effect of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime on a soil which has been under sisal for a lengthy period in the Kibwezi area.

Locality.—Dwa Plantations Limited, Kibwezi.

Date of commencement.—18th April, 1953.

Spacing.—13 ft. + 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

Sisal waste at rates of 25, 50 and 100 tons per acre.

Double superphosphate at rates of:—

150 lb. per acre at planting.

150 lb. per acre at planting plus one repetition.

150 lb. per acre at planting plus three repetitions during the cycle.

Agricultural lime two tons per acre.

Design.—2⁵ factorial confounded. Plots split for N in March, 1954.

There are no responses to phosphate or to lime in this trial but the responses to sisal waste and nitrogen are outstanding. In the following tables on leaf count it is well to bear in mind that the figures expressed are for individual plants and in order to arrive at the proper economic implications these figures have to be multiplied by the plant population (1,980 plants per acre).

LEAVES PRODUCED	SISAL WASTE PER ACRE			
	No waste	25 tons	50 tons	100 tons
From planting April, 1953 to August, 1953	2.1	3.1	4.3	7.0
From August, 1953 to March, 1954 ..	14.4	17.4	18.8	20.2
From March, 1954 to March, 1955 ..	48.6	51.0	52.7	54.3
From March, 1955 to March, 1956 ..	36.9	38.8	40.2	40.7
From March, 1956 to August, 1956 ..	6.1	6.3	6.8	6.7
Total leaf count to August, 1956 ..	108.1	116.6	122.8	128.9

The effect on leaf count of applying Nitrogen with sisal waste can be expressed as follows:—

	SISAL WASTE PER ACRE				Mean for N.
	No waste	25 tons	50 tons	100 tons	
No N.	103.7	113.9	118.9	126.7	115.8
With N.	112.4	119.1	126.8	131.0	122.3
Increase	8.7	5.2	7.9	4.3	6.5

The application of N has been as effective to date as the application of 25 tons of sisal waste, and likewise the application of 25 tons waste and nitrogen has been as effective as 50 tons waste. This subject must be studied further in conjunction with fibre yields as a smaller application of waste with nitrogen added may be more economical than the larger sisal waste applications.

The results for leaf length are similar to those for leaf count with phosphate and lime giving no significant results, while 25 tons waste has increased the length of the last leaf unfurled by nearly 3 in. which is similar to the effect of nitrogen. The 50-ton application has to date increased the leaf length by 6 in. but this increase is partly due to the higher leaf number per plant in these plots.

The trial is cut when the average number of leaves produced per plant since planting reaches 120; some of the plots had reached this stage in August, 1956, and the rate of increase in growth can best be seen as follows:—

Where no waste was applied three of the 16 plots were cut.

Where 25 tons of waste was applied ten of the 16 plots were cut.

Where 50 tons of waste was applied 13 of the 16 plots were cut.

Where 100 tons of waste was applied 16 of the 16 plots were cut.

Of the other fertilizers only sulphate of ammonia indicated the need for a slightly earlier first cut, but with less than two-thirds of the trial cut comparisons with this factor will have to be postponed.

The yield of fibre obtained in the first cut ranged from 0.90 to 1.10 tons per acre but comparisons cannot be made till the whole trial has had its first cut.

A notable feature in this trial was the condition of the leaves which was good, despite the two dry years since planting, and it is felt that this must, to a large extent, be attributed to the shading of the soil beneath the plants in a double row.

EXPLORATORY FERTILIZER TRIAL, KITALE

Object.—To investigate the effect of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime on old sisal land in the Kitale area where symptoms of deficiency diseases have been noticed on sisal.

Locality.—Zea Estate Limited, Kitale.

Date of commencement.—9th July, 1953.

Spacing.—13 ft. + 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

Treatments.—

Sisal waste at rates of 25, 50 and 100 tons per acre.

Double superphosphate at the rates of:—

150 lb. per acre at planting.

150 lb. per acre at planting plus one repetition.

150 lb. per acre at planting plus three repetitions during the cycle.

Agricultural lime: two tons per acre.

Sulphate of ammonia: $2\frac{1}{2}$ cwt. before each rain for three years commencing April, 1954.

Design.— 2^5 factorial confounded. The plots were split for sulphate of ammonia.

After the recording for growth rate in October, 1956, the following deductions can be made:—

There is no response to agricultural lime or to double superphosphate expressed in the number or length of leaves produced in this trial, but both the sisal waste and N applications have produced significant responses. It appears that the effect of the sisal waste application was mainly in the initial boost which lasted for about 18 months after which the advantage gained was retained but not increased. The increases in the *leaf counts per plant* in the plots receiving

waste did not vary much between the recording after 22 months and the recording after 39 months and were as follows:—

	No waste	25 tons	50 tons	100 tons
After 22 months	37.7	39.5	44.7	49.6
After 39 months	79.6	81.0	87.2	91.2
Increase over control after 22 months	—	1.8	7.0	11.9
Increase over control after 39 months	—	1.4	7.6	11.6

The repeated applications of sulphate of ammonia showed the greatest responses after the plants had been in the ground well over a year. The effect after 15 months was negative (-0.4), but non-significant, but the subsequent application boosted the rate of leaf production by 3.5 and 2.8 leaves per plant in the two years following and so the total effect at October, 1956, was that the plants receiving N had on average produced 87.7 leaves while those without N had produced 81.8, a difference which is highly significant ($P=0.001$).

RATES OF APPLICATION TRIAL

Object.—To ascertain the optimum rates needed for an economic return of sisal waste, double superphosphate, sulphate of ammonia and agricultural lime.

Locality.—High Level Sisal Research Station, Thika.

Date of commencement.—10th October, 1954.

Spacing.—13 ft. + 3 ft. $\times$ 2 ft. 9 in. (1,980 plants per acre).

Treatments

Fresh sisal waste—

No application.

25 tons per acre.

50 tons per acre.

Double superphosphate—

No application.

181.5 lb. per acre (75 lb. P_2O_5).

363.0 lb. per acre (150 lb. P_2O_5).

Sulphate of ammonia—

No application.

2½ cwt. per acre in two applications per annum.

5 cwt. per acre in two applications per annum.

Agricultural lime—

No application.

Two tons per acre.

Four tons per acre.

Design.—3⁴ Quasi Latin square.

There is no response shown in leaf count or leaf length as a result of application of lime in this trial, and the small effect due to double superphosphate is seen only in the leaf length, the leaves being increased by about $\frac{1}{4}$ in. which is insignificant.

The effect of sisal waste and nitrogen and their interaction is best expressed as follows (based on leaf count for October, 1956):—

	SULPHATE OF AMMONIA			Mean for waste
	Nil	2½ cwt.	5 cwt.	
Sisal waste: Nil	64.3	69.3	68.5	67.4
Sisal waste: 25 tons per acre ..	70.2	72.6	75.9	72.9
Sisal waste: 50 tons per acre ..	75.8	77.4	80.0	77.7
Mean for N.	70.1	73.1	74.8	

The average increase in the leaf count of those plots receiving 25 tons sisal waste per acre is 5.5 leaves more per plant than the control plots while a 50-ton application has increased the number by 10.3 leaves during the first two years' growth; this is considerably more than the increase due to sulphate of ammonia.

The average rate of leaf production per plant over the two years this trial has been in the ground can be expressed as follows:—

	No waste	25 tons waste	50 tons waste	No N.	2½ cwt. N.	5 cwt. N.
1 year ..	29.4	33.3	36.6	32.6	33.3	33.2
2nd year ..	38.0	39.6	41.1	37.5	39.8	41.6
Total to date	67.4	72.9	77.7	70.1	73.1	74.8

It will be seen that after the first year the plots receiving 50 tons of waste had produced seven leaves more per plant than the control while they produced only three leaves more during the second year.

PHOSPHATE COMPARISON TRIAL

Object.—To ascertain the effects on sisal of applying phosphate in various forms.

Locality.—High Level Sisal Research Station, Thika.

Date of commencement.—31st October, 1956.

Treatments.—75 lb. P_2O_5 per acre applied as:—

187.5 lb. double superphosphate at 40 per cent P_2O_5 .

312.5 lb. rock phosphate at 24 per cent P_2O_5 .

416.6 lb. basic slag at 18 per cent P_2O_5 .

Design.—Four randomized blocks of four plots each.

Spacing.—13 ft. + 3 ft. × 2 ft. 9 in. (1,980 plants per acre).

This trial is more in the nature of an observation plot so the variations have got to be substantial to be significant.

The phosphate was applied in holes under the plants at the time of planting. There are no discernible variations as yet, the trial being so young.

FURTHER EXPLORATORY FERTILIZER TRIALS

The object of the following three exploratory fertilizer trials is to investigate the effect on the growth rate of sisal by the application of fresh sisal waste at rates of $12\frac{1}{2}$, 25 and 50 tons at planting with additional applications at the same rate after 18 and 36 months, double superphosphate at the rate of 365 lb. per acre, agricultural lime at the rate of two tons per acre and sulphate of ammonia at the rate of 5 cwt. per acre per year for three years in two applications of $2\frac{1}{2}$ cwt. per acre before each rain.

The spacing in all three trials 13 ft. $\times$ 3 ft. $\times$ 2 ft. 9 in. (1,980 plants per acre).

Design.— 2^5 factorial confounded.

EXPLORATORY FERTILIZER TRIAL, VOI

Locality.—Voi Sisal Estate Limited, Voi.

Date of commencement.—15th March, 1954.

The drought conditions prevailing in the Voi district since this trial was planted are manifest in the extremely slow rate of growth.

During the first year this trial was in the ground the rainfall was just over 13 in. and in the second year it was in the region of 21 in. From March, 1956, to August the drought hit the plants so hard that not only was the average leaf increase barely half a leaf per plant but the leaves were drying up and collapsing. The rate of growth over the period can be expressed as follows (those treatments showing a response only):—

	(1)	$12\frac{1}{2}$ tons waste	25 tons	50 tons
Leaf growth—				
1st year	13.4	13.8	13.5	15.4
2nd year	20.0	19.5	20.5	24.0
Next six months	0.5	0.7	0.7	0.8
Total to date	33.9	34.0	34.7	40.2

There was no response from the plots receiving applications of double superphosphate but small, and just significant, responses to nitrogen and agricultural lime were seen.

It is, however, heartening to record that after a rainfall of about 6 in. during the first half of November, 1956, the plants all revived and raised their leaves. Although the plants have not got the robust appearance one could wish for it is possible that future work and treatments on the trial will show some results, this however will obviously depend on the future rainfall and temperature.

A promising feature, after $2\frac{1}{2}$ years, was the appearance of a weed cover. Until this happened the soil had been hard baked and of very high temperature, a condition which does not induce root development in a shallow rooted crop like sisal.

EXPLORATORY FERTILIZER TRIAL, RUIRU

Locality.—B. E. A. Planting Co. Limited, Ruiru.

Soil.—Murram.

Date of commencement.—2nd April, 1954.

Apart from agricultural lime, to which there was no significant response, this is a most satisfying trial with generous responses to the treatments given.

The response to double superphosphate has been to increase the leaf count from 70 leaves per plant to an average of 74.5 leaves, an increase which took place within the first year and although this has been maintained so far, further increases were small and insignificant.

The increase due to the applications of sulphate of ammonia to date amounts to eight leaves per plant more than the control which has an average of 68.2 leaves per plant. The effect of the first application given six months after planting was negligible but after that a steady increase has been maintained; the growth rates being as follows:—

	No N	N	Increase
First year	30.1	30.0	-0.1
Second year	29.6	34.7	5.1
Next six months	8.5	11.5	3.0
Total Leaf Count to date	68.2	76.2	8.0

The same response is reflected in the leaf length, the length of the last unfurled leaf is now 4 in. longer in plots where N has been applied.

The rates of leaf growth due to the various rates of sisal waste applications are as follows:—

	No waste	12½ tons	25 tons	50 tons
1st year	27.2	28.3	30.3	34.5
2nd year	30.3	31.8	31.9	34.4
Next six months	8.9	10.2	10.4	10.7
Total	66.4	70.3	72.6	79.6

The increases over the control due to the different sisal waste applications were falling off during the second year and the differences between the sisal waste applications are negligible during the third year's growth, the speedier growth may be due to the bigger size of the plants rather than to residual effects of the waste application.

At the end of the first year the increase over the control due to 12½ tons sisal waste was 1.1 leaves per plant. Twenty-five tons of waste has increased that further by 2.0 leaves to 3.1 leaves per plant while the 50-ton application was 4.2 leaves better than the 25-ton, or a total of 7.3 leaves more than the control, so whenever the waste application was doubled the response was also doubled during the first year.

In the second year there was little difference in the responses to 12½ and 25 tons waste while 50 tons increased the leaf count by about four leaves over the control plots.

A further sisal waste application will be given to this trial during 1957.

EXPLORATORY FERTILIZER TRIAL, KAMPI-YA-MOTO

Locality.—Lomolo Sisal Estate, Kampi-ya-Moto.

Date of commencement.—16th April, 1954.

There were no significant responses to double superphosphate and agricultural lime in this trial, which is also the only trial in which no response to the small application of 12½ tons of sisal waste has been obtained.

The leaf count response to sisal waste is not very spectacular over the first two years and *the average rate of leaves produced per plant* is as follows:—

	Control	12½ tons waste	25 tons	50 tons
1st year	18·6	18·3	19·8	22·0
2nd year	39·6	40·4	41·8	42·3
Next six months	16·1	16·0	16·9	17·7
	74·3	74·7	78·5	82·0

Although the responses to 25 tons and 50 tons of sisal waste are statistically significant it is problematical whether the increased growth of 7.7 leaves per plant over the control when applying 50 tons waste per acre is of economic interest, even when it is remembered that this applies to applications on 1,980 plants per acre. The result has been an addition of approximately 15,000 leaves more per acre in the field but as these additional leaves are produced during the first two years, of which a great proportion will not be cut due to short length, results of the cuttings will have to be seen before a recommendation can be made.

The responses to sulphate of ammonia are however more clearly seen. The effect has, to date, been to increase the average leaf count from 71.6 leaves on the untreated plots to 83.2 leaves per plant on the treated plots. The first application, given six months after planting, had no apparent effect but the increase thereafter has been steadily maintained. The increase in the first year amounted to 1.3 leaves per plant, the second year to 6.8 and the following six months to 3.4 additional leaves per plant.

The rates of application of sulphate of ammonia are heavy and may prove uneconomic in practice, but there would appear to be very good reason to follow up the present information by Rates Trials to ascertain not only in what form to apply N on these soils but also the lowest rates at which it is effective.

Production of Improved Planting Material Trials

HYBRID VARIETY TRIAL

Object.—To observe and compare the performance of common sisal with eight promising hybrids received from Mlingano Experimental Station, Ngomeni, Tanganyika Territory.

Date of commencement.—7th April, 1952.

Treatments.—Eight hybrids obtained from Mlingano Experimental Station, Tanganyika Territory, are compared with common sisal.

Planting.—13 ft. + 3 ft. × 2 ft. 9 in.

Design.—3 × 3 balanced lattice. Nine treatments and four replications.

The last recording for growth took place in October, 1956, with the following results:—

	No. of leaves grown since planting	Length of last leaf in inches
<i>Agave sisalana</i>	156	in. 47·8
Hybrid No.—		
1155	190	33·2
1269	250	36·9
1300	207	42·3
1317	267	37·4
1475	204	43·2
1660	248	40·9
6964	252	40·0
7131	249	33·3

The timing of first cut which took place in this trial in October, 1956, was determined by the length of the last leaf unfurled (about 3 ft. long was decided on) irrespective of the number of leaves produced. In the case of Hybrid No. 7131 this rule was not adhered to as the leaf count was in the region of 245 while the length of the last leaf was only about 31 in., and it was felt that the plants were unlikely to produce a leaf of the required length.

Agave sisalana and Hybrids No. 1317, 1475 and 6964 were cut throughout the trial while only three-quarters of 1300, 1660 and 7131 was cut, one-quarter of 1269 was cut and nothing in Hybrid 1155. The cuts being incomplete, do not give sufficient information for comparisons to be made at this date.

None of the Hybrids would appear to be better than *Agave sisalana* at present and a comparison of the three Hybrids which have had the same cut as common sisal is as follows:—

	<i>Agave sisalana</i>	1317	1475	6964
No. of leaves cut per plant	38	34	15	52
Fibre tons per acre	0·84	0·35	0·30	0·76
1,000 leaves per ton fibre	90·0	199·0	108·0	142·0
Fibre percentage	2·26	2·82	2·78	2·77

The number of leaves needed per ton of fibre is so much greater than for common sisal that one is likely to lose interest in these plants unless a substantial increase in leaves per plant is ultimately attained. This conclusion applies equally well to the "non-flowering" sisal plants being tested in another trial, here also no further report will be made until after it has had additional cuts.

Herbicide Trials

No new trials were planted during 1956 with the specific object of testing the effect of Herbicides on sisal.

Numerous observation plots have, however, been started to ascertain the effect of herbicides on sisal and weedgrowth, and although a great deal of the information gathered is negative and of no interest to the grower, it is of great value to the research worker.

No conclusive results have been obtained from herbicides on broad-leaved weeds in nurseries, nor has their effect on growing sisal been definite or consistent.

The most promising results have been obtained with Dowpon (previously referred to as Dalapon) against couch grass (*Degitaria scalarum*). Part of a ploughed area known to be full of couch was sprayed on 29th September at the rate of 15 lb. Dowpon in 100 gallons of water per acre. The soil was dry although 0.22 in. of rain fell in the two days before the application, there was no rain for seven days after the application and then 0.50 in. fell in two days, followed again by 21 days without rain.

As no couch appeared during the month following the spraying with Dowpon a trial was planted on the area on 31st October and in spite of receiving over 9½ in. of rain till the end of the year, the area has remained completely free of couch whilst the adjoining areas are heavily infested. Later on, experiments with the same herbicide were carried out in conjunction with Messrs. Fisons Pest Control Limited, using a logarithmic boom sprayer from a Land-Rover, with the same striking results.

Sisal plants sprayed with Dalapon in 1955 developed a leaf dieback with a severity directly related to the amount of Dowpon applied. New leaves unfurling appear, however, to be unaffected, and no distortion of the growing parts has been observed.

K. LERCHE,
Senior Assistant Agricultural Officer (Sisal).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), NYANZA PROVINCE, 1956

Weather

RAINFALL AT EXPERIMENTAL STATIONS 1956 (INCHES)

	Kaka- mega	Kisumu	Kibos	Miwani	Kisii	Homa Bay	Sotik	Sotik Post
Jan.	7.55	6.90	12.52	7.10	4.33	1.73	7.40	8.76
Feb.	2.65	2.50	0.94	0.85	1.57	1.88	3.94	2.91
Mar.	6.80	4.32	5.22	4.72	5.24	3.28	4.04	5.74
Apr.	7.28	6.73	4.95	6.13	10.40	9.73	8.05	5.11
May	9.00	4.74	3.34	5.90	14.74	13.66	5.06	2.75
June	5.55	6.99	5.77	4.00	6.02	2.77	3.11	0.96
July	5.54	0.76	0.72	2.60	3.66	4.19	2.53	1.73
Aug.	10.54	3.43	4.51	5.50	4.68	5.22	6.48	3.37
Sept.	6.35	2.35	4.54	1.15	9.84	1.69	3.34	3.78
Oct.	5.19	1.30	0.77	4.26	7.63	2.93	1.64	2.55
Nov.	3.48	0.65	1.67	1.78	6.57	1.96	3.29	2.51
Dec.	3.70	9.68	4.56	4.40	3.42	2.02	2.53	2.26
Total	73.63	50.35	49.51	48.39	78.10	51.06	51.41	42.43

Rainfall distribution was good at all stations except Sotik. There was little or no dry season at the beginning of the year which was unusual for the Province. Midseason hailstorms, some of great violence, caused a great deal of crop loss, especially among exploratory fertilizer trials in North and Elgon Nyanza.

The year ended with the normal tailing off of the rains and by the end of December the dry season proper had set in.

Reports on Experiments

COFFEE VARIETY TRIAL, KISII

This full scale variety trial was planted in 1950 to test seven varieties of Arabica coffee in a 7×7 latin square with nine trees per plot at 9×9 ft. spacing on mulched box ridges.

Yields have been recorded since 1954 (*see* 1954 and 1955 Reports). At the time of writing it is not possible to report on the 1956 crop as final figures are not yet available.

DRAINAGE AND PHOSPHATE TRIALS ON VLEI SOILS

This year each of the eight drainage treatments at Sotik Post (design reported in 1955) was planted up in strips to maize, potatoes and wheat, also

tested against these crops was an application of 100 lb. per acre double superphosphate versus nil. Treatment and yield figures were as follows:—

1. Plots receiving free flow of water from higher land
lb./acre

A—24 ft. ridge and furrow (1 per cent slope) with phosphate	2,896	(maize)
	4,180	(potatoes)
	848	(wheat)
B—24 ft. ridge and furrow (1 per cent slope) with no phosphate	2,622	(maize)
	2,185	(potatoes)
	568	(wheat)
C—Flat with phosphate	1,608	(maize)
	2,928	(potatoes)
	378	(wheat)
D—Flat with no phosphate	Maize yield approx. $\frac{1}{2}$ of (A) above, but not yet threshed	
	<i>lb./acre</i>	
	2,800	(potatoes)
	529	(wheat)

2. Plots protected on upper side by a bank and a cut-off drain
lb./acre

E—24 ft. ridge and furrow (1 per cent slope) with phosphate	4,372	(maize)
	4,760	(potatoes)
	689	(wheat)
F—24 ft. ridge and furrow (1 per cent slope) with no phosphate	3,133	(maize)
	3,759	(potatoes)
	529	(wheat)
G—Flat with phosphate	3,861	(maize)
	2,952	(potatoes)
	868	(wheat)
H—Flat with no phosphate	2,184	(maize)
	792	(potatoes)
	756	(wheat)

In 1956 this trial was put to a fair test by the prevailing weather conditions at Sotik Post and all drainage treatments had a chance to operate, which they did not in 1955. Although the trial is only observational in design the clear advantage of the top cut-off drain can be seen by comparing figures in section 2 with those in section 1. The advantage of the ridge and furrow treatment versus flat ground is clear in most cases, as is also the response of all crops to a dressing of 100 lb. double superphosphate per acre.

EXPLORATORY FERTILIZER TRIALS

37 new exploratory trials were planted in the province in 1956, the object being to follow up the E.A.A.F.R.O.-sponsored work of earlier years. The design was a 2^4 factorial to compare FYM at $7\frac{1}{2}$ tons per acre versus nil, double supers at 1 cwt. per acre versus nil, sulphate of ammonia at 1 cwt. per acre versus nil, and muriate of potash at 1 cwt. per acre versus nil.

Sites were selected according to the major soil types in each district and the object was to try to put three replications on each soil type so that a good statistical comparison could be made. At the time of writing not many of the results are to hand and so will not be reported on here.

A list of districts with the number of replicates planted in each is given below:—

Elgon Nyanza	..	..	..	..	..	12 replicates
North Nyanza	..	..	..	..	..	12 „
South Nyanza	..	..	..	..	..	7 „
Central Nyanza	..	..	..	..	..	6 „
Kericho (African areas)	..	..	..	..	..	nil in 1956

FERTILIZER RATES TRIALS

The trial at Sotik Experimental Station to compare 4 rates of sulphate of ammonia and 4 rates of double superphosphate application was continued with no reapplication of fertilizers to test residual effects of the 1955 dressings. Only one replicate was yield tested as it was found that natural fertility differences in the second replicate were so great as to bias any result that might be obtained from it. The crop was maize.

Yield figures are given below in bags (200 lb.) dry maize grain per acre:—

DOUBLE SUPERPHOSPHATE				SULPHATE OF AMMONIA			
Rate (residual)			Yield/acre	Rate (residual)			Yield/acre
1.44 cwt./acre	..	..	14.99	1.44 cwt./acre	..	..	11.65
0.96 cwt./acre	..	..	18.08	0.96 cwt./acre	..	..	15.06
0.48 cwt./acre	..	..	9.32	0.48 cwt./acre	..	..	14.30
Nil	..	..	13.10	Nil	..	..	14.49
Mean	..	..	13.87	Mean	..	..	13.87

LEAST SIG. DIFF.—

P=0.05	5.10 bags/acre	5.10 bags/acre
P=0.01	7.42 bags/acre	7.42 bags/acre

There was a good residual response to superphosphate at the 0.96 cwt. per acre level giving an economic gain over control; this increase was not quite statistically significant. There was no response to residual nitrogen, this was to be expected as there was no response to the original dressings of sulphate of ammonia in 1955. There was no response to any of the interactions between the two fertilizers.

At Kapkatet (Kericho District) a residual trial was carried out in 1955 with maize on the same lines as the foregoing, to test the residual effect of 4 rates each of sulphate of ammonia and double superphosphate originally applied in 1954. Results were not reported in 1955 as figures were not to hand.

Yield figures are given below:—

DOUBLE SUPERPHOSPHATE				SULPHATE OF AMMONIA			
Rate (residual)			Yield—bags (200 lb.)/acre	Rate (residual)			Yield—bags (200 lb.)/acre
1.44 cwt./acre	..	..	14.78	1.44 cwt./acre	..	..	14.68
0.96 cwt./acre	..	..	16.81	0.96 cwt./acre	..	..	16.14
0.48 cwt./acre	..	..	15.20	0.48 cwt./acre	..	..	14.49
Nil	..	..	14.62	Nil	..	..	16.08
Mean	..	..	13.35	Mean	..	..	13.35

LEAST SIG. DIFF.—

P=0.05	3.16	3.16
P=0.01	4.41	4.41

There were no significant differences between any fertilizer residues or their interactions one with another.

A new trial was started at Sotik Post (Bomet) with maize as the crop to compare applications of double superphosphate at 0, 75 lb., 150 lb. and 225 lb. per acre with sulphate of ammonia at 0 and 112 lb. per acre and with muriate of potash at 0 and 112 lb. per acre. The trial was laid down in two replications but one only came to fruition as the second was badly flooded in the early stages. A large response to phosphate is evident from all three treatment levels, no response to either sulphate of ammonia or muriate of potash is apparent.

Yields in bags (200 lb.) of maize grain are given below:—

DOUBLE SUPERS.		SULPHATE OF AMMONIA		MURIATE OF POTASH	
Rate lb./acre	Yield	Rate lb./acre	Yield	Rate lb./acre	Yield
225 ..	10.66	112 ..	8.71	112 ..	8.40
150 ..	9.98	Nil ..	8.46	Nil ..	8.77
75 ..	8.35				
Nil ..	5.33				
Mean ..	8.58		8.58		8.58

It is not possible to provide figures for significance tests as the final analysis has not been completed.

PHOSPHATE, METHOD OF APPLICATION

A new trial was started at Sotik Experiment Station to compare the application of 210 lb. per acre of double supers applied once in three years against 105 lb. per acre applied in two seasons out of three, and 70 lb. per acre applied each year, versus nil. These treatments are applied to a series of arable crops, the rotation being potatoes, maize, wheat. The design is a 4×4 balanced lattice square with 5 replications. This is a long term trial and results will not be to hand for some years.

FARMYARD MANURE AND PHOSPHATE TRIAL

This trial was continued at Kisii with maize as the crop and with reapplication of double superphosphate at 340 lb. per acre and 170 lb. per acre, the object being to discover whether or not there would be a response to a large dressing, the past history of the trial having shown very small responses to the former treatments of 112 and 66 lb. per acre of double supers.

Farmyard manure was not reapplied. Yield figures are given below in bags (200 lb.) per acre of maize grain.

DOUBLE SUPERS.				FARMYARD MANURE (APPLIED 1955)			
Rate			Yield	Rate			Yield
340 lb. per acre	..	..	11.49	10 tons per acre	..	..	11.48
170 lb. per acre	..	..	11.75	2½ tons per acre	..	..	11.81
Nil	..	..	11.68	Nil	..	..	11.63
Mean	..	..	11.64	Mean	..	..	11.64

LEAST SIG. DIFF.—

P=0.05	..	..	1.69	1.69
P=0.01	..	..	2.30	2.30

There were no significant responses to either the new phosphate dressings or to the F.Y.M. dressings applied in 1955, or to their interactions. The trial, which has been running since 1952 is now concluded.

FODDER CROP OBSERVATION PLOTS

Since the report of last year it has become evident that of the fodders tried in Nyanza, Napier grass has been the most successful, and work has continued with this grass in an attempt to find an optimum inter-row spacing. At Sotik and at Kapkatet it has been found that in its first year Napier will yield as heavily at 6 ft. inter-row spacing as it will at 3 ft.

Attempts to combine a climbing legume, either *Dolichos* spp. or *Glycine javanica* with Napier as a protein supplement have as yet proved unsuccessful, the legume dying out after its first year of cutting. At Sotik new plots were established of Velvet beans and of perennial *Dolichos* in pure stand; results are disappointing as both legumes virtually died out after their first cut in November, due mainly to the dry conditions prevailing immediately afterwards. At Sotik Post and Kabosson work continues with fodder beet and mangolds, which seem especially suited to this area, particularly with an application of 1 cwt. per acre of double superphosphate; yields are expected to be satisfactory but final figures are not available at the time of writing.

LEY SPECIES OBSERVATION PLOTS

The very small ley species observation plots in the various ecological zones of the Province were discontinued in 1956 as it was felt that they had served their purpose, which was to find out which grasses would thrive under the differing conditions; these findings were published in the previous Annual Report.

In the high rainfall areas of Kakamega and Kisii it is evident that Nzoia Rhodes and Nandi *Setaria* are the most promising of the seeded grasses, but at these sites where Star and/or Kikuyu grasses comprise the natural sward it

is also evident that the indigenous types tend to take over the sown ley to a great extent after the second year.

At Sotik there is evidence that Nzoia Rhodes and Nandi *Setaria* do persist into the third year but that their productivity falls off at this stage.

Grass/legume grid trials now in their second year at Kakamega and Sotik have been disappointing. At Sotik virtually all the legumes have gone out; Molasses grass has persisted well as has Nandi *Setaria* but an unidentified broad leaved weed has encroached in profusion. The Kakamega grid is somewhat more satisfactory where lucerne and *Trifolium semipilosum* retain their vigour, but the annual legumes *Medicago denticulata* (Burr medick) and *T. ruepellianum* have reappeared only sparsely despite being allowed to reseed at the onset of the rains. Of the sown grasses Nzoia Rhodes and Nandi *Setaria* have persisted well, the former being the most palatable to stock. *Paspalum dilitatum* appears in patches only and follows the usual pattern for this grass, being very slow to germinate and consequently being swamped by indigenous species.

An observational Star grass trial (planting splits) carried out at Kakamega showed that, under conditions of high rainfall and heavy weed growth, a spacing of 3 ft. by 3 ft. for planting splits is about the widest for obtaining a successful cover; wider spacings are early taken over by weeds.

At Kakamega a 10-acre field was sown in two halves to Nzoia Rhodes and to Nandi *Setaria*. These grasses were combined with inoculated seed of *Medicago denticulata* and *T. ruepellianum*, which were the two annual legumes that had shown promise in the 1955 grid trial. Grasses and legumes were sown in August and to date both legumes have shown a very poor take.

GROUNDNUT VARIETY TRIAL

At Kabosson a trial of eight groundnut varieties in four randomised blocks was carried out. The plot size was 1/193 acres, spacing 3 ft. × 2 ft. on 3 ft. tied ridges. Due to exceedingly heavy termite attack, and to a lesser extent rosette disease, yields were very low indeed.

The varieties U/A—32=S. 720 and Nyanza local (Njugu machon) significantly outyielded all others at the 1 per cent level. The order in which the varieties stand in the following table is interesting and confirms results at Homa Bay in 1955 in that they are almost identical with the order in which they stood at the former trial. Varietal yields are given below:—

VARIETY	Lb. dry shelled nuts per acre
U/A—32=S.720	142·80
Nyanza local (Njugu machon)	129·60
Homa Bay Farm variety	84·00
SA/A—1=A.H. 32	69·60
SA/A—2=Masambika	66·00
SA/A—5=42-G-105	61·20
Nyanza local (Valencia Bunch)	54·00
U/A—8=B.688	40·80
Mean.. .. .	81·00
LEAST SIG. DIFF.—	
P=0·05	14·40
P=0·01	21·60

POTATO VARIETY OBSERVATION PLOTS

Three "blight resistant" potato varieties, K.52, C.53 and E.52 were planted for observation in November at Kakamega and at Kisii. These varieties were ex Scott Laboratories. The potatoes have not yet been harvested but observations to date show very little blight at Kisii, but at Kakamega both C.53 and E.52 have been severely attacked by a leaf spot followed by wilting which has been tentatively described as *Alternaria* late blight. K.52 has withstood the attack quite well. At Kakamega a few rows of Kipsigis grown potatoes were sown with the varieties under test and these, though slower in growth, show no sign of the leaf spot as yet.

RICE OBSERVATION PLOTS

Work at Namasaria under controlled irrigation was confined to the roguing and pure seed production of the variety Shingo la Majane.

At Komomange in Suba/Kuria division of South Nyanza a small non-statistical varietal trial was carried out in a hanging swamp. Irrigation was not controlled and seed was broadcast at 100 lb./acre and each variety was replicated three times. Yields were low, mainly due to insufficient water:—

Variety	Mean Yields in bags (160 lb.) per acre						
Mbuyu	..	..	..	..	..	..	5.64
Kihogo	..	..	..	..	..	..	2.57
Sindano	..	..	..	..	..	..	0.79

SORGHUM VARIETY TRIAL, HOMA BAY

This trial was laid down in an attempt to confirm the findings of a similar trial at Homa Bay in 1955. The design was similar to the former trial and all the varieties were white grained except the local type. The two varieties Dobbs ex Bukura and Enyanza ex Tanganyika outyielded significantly all other varieties excluding B.C.81 and the red local sorghum. Dobbs and Enyanza were second and third respectively in the 1955 trial. The 1956 yields are in the main much higher than formerly, possibly due to the enhanced rainfall. S.U.K.1 and Dwarf Shallu are early varieties and were badly attacked by birds. Yield figures were:—

Variety	Bags (180 lb.) per acre						
Dobbs ex Bukura	..	..	..	..	..	..	14.51
Enyanza	..	..	..	..	..	..	13.97
B.C.81	..	..	..	..	..	..	11.50
Homa Bay Farm	..	..	..	..	..	..	11.39
Oklahoma	..	..	..	..	..	..	9.89
B.C.27	..	..	..	..	..	..	9.67
Dobbs ex Kongwa	..	..	..	..	..	..	9.24
S.U.K.1	..	..	..	..	..	..	1.82
Dwarf Shallu	..	..	..	..	..	..	1.40
Mean	..	..	..	..	..	..	9.26

Least Sig. Diff.

P=0.05	..	..	..	..	..	..	2.89
P=0.01	..	..	..	..	..	..	3.91

SUGAR CANE VARIETY TRIALS

The trial of eight varieties in four randomized blocks at Kakamega was abandoned before its second ratoon harvest, due to immense differences between and within plots caused by ratoon stunting disease and to a certain extent to theft. At harvest time the trial was critically examined before this decision was made.

The trial of five varieties selected from an earlier completed trial has gone through to its first ratoon harvest. This is a 5×5 latin square design planted on the upper red soil of Miwani Estate and duplicated on the lower black soil. The first ratoon crop of the upper red soil trial was reported in the 1955 Report. Yields of cane and of sucrose are given below for the first ratoon of the trial on the lower black soil:—

VARIETY	Yield (tons cane/ acre)	Yield of Sucrose (tons/acre)
Co.331	36.55	4.25 (calculated by Java ratio)
Co.419	29.60	3.71
Co.408	25.47	3.14
Co.213	21.53	2.45
Co.421	21.45	2.59
Mean	26.92	
LEAST SIG.—DIFF.—		
P=0.05	3.46	
P=0.01	4.78	

Co.331 gave a significantly higher yield than any other variety, as it did in the 1st ratoon of the trial on the upper red soil. The mean fall in yield from plant crop to 1st ratoon over the whole trial is about 42 per cent, which is very high. The probability is that the whole trial is infected with ratoon stunting disease, which is prevalent in the area.

SUGAR CANE VARIETY TRIAL, MIWANI

The plant crop of this trial of 16 varieties was reported in 1955. The 1st ratoon crop was harvested in September 1956. Yields of cane are shown below together with the sucrose yield (calculated by Java ratio) in tons per acre:—

VARIETY	Yield of cane (tons/acre)	Sucrose Yield (tons/acre)
Co.453	65.74	8.52
Co.421	53.39	6.25
Co.290	53.23	6.03
N.Co.330	51.30	6.82
B.37193	51.01	6.62
Co.411	49.62	5.77
B.41227	48.11	5.72
B.3337	44.54	5.05
Co.281	42.97	5.79
C.P.34/120	40.13	5.02
N.Co.291	33.98	4.45
P.O.J.2961	33.87	4.31
N.Co.79	32.64	4.04
B.3257	30.80	4.11
C.P.36/105	25.75	2.91
C.P.34/79	21.62	2.96
Mean	42.42	
LEAST SIG. DIFF.—		
P=0.05	10.14	
P=0.01	12.96	

The mean yield is higher for the 1st ratoon crop than for the plant crop, possibly due to rather dry conditions during some of the establishment months of the plant crop.

Co.453 has outyielded all other varieties at the 5 per cent level and has outyielded all varieties listed below Co.290 at the 1 per cent level. The order of the varietal yields in the 1st ratoon bears little relationship to those of the plant crop, with the exception that Co.453 was third in the plant crop at 47.82 tons per acre.

SUGAR CANE VARIETY TRIAL, MIWANI

A trial of 25 varieties was planted in September 1954 to compare with the best varieties tested to that date other new varieties from the cane collection at Kisumu. The design is a 5×5 balanced lattice square with three replications. Plot size 30 ft. $\times$ 29 ft. = 1/50th acre. The plant crop was harvested in April, 1956. Yield figures of cane and of sucrose in tons per acre are given below:—

VARIETY						Cane Yield (tons/acre)	Sucrose Yield (tons/acre)
Co.419	..	..	..	..	..	66.01	7.13
N.Co.339	..	..	..	..	..	63.44	6.76
Co.331	..	..	..	..	..	62.39	5.68
N.Co.334	..	..	..	..	..	62.26	6.42
Co.301	..	..	..	..	..	61.97	6.47
Co.434	..	..	..	..	..	61.00	6.18
N.Co.349	..	..	..	..	..	59.80	6.42
Co.312	..	..	..	..	..	58.30	6.14
Co.411	..	..	..	..	..	55.02	4.99
B.41227	..	..	..	..	..	54.96	5.61
N.Co.330	..	..	..	..	..	53.49	6.19
N.Co.291	..	..	..	..	..	52.99	5.53
N.Co.310	..	..	..	..	..	52.03	6.05
Co.281	..	..	..	..	..	50.75	5.26
Co.453	..	..	..	..	..	50.61	5.15
Co.421	..	..	..	..	..	48.29	5.13
P.O.J.2875	..	..	..	..	..	45.95	4.84
B.37193	..	..	..	..	..	45.90	4.40
Co.408	..	..	..	..	..	45.82	5.86
N.Co.79	..	..	..	..	..	45.10	4.75
P.O.J.213	..	..	..	..	..	43.57	4.14
P.O.J.2961	..	..	..	..	..	43.08	4.55
B.3337	..	..	..	..	..	42.23	4.26
B.4362	..	..	..	..	..	41.09	5.32
Co.213	..	..	..	..	..	36.59	3.28
Mean	..	..	..	..	..	52.10	
LEAST SIG. DIFF.—							
P=0.05	..	..	..	..	..	10.26	
P=0.01	..	..	..	..	..	13.91	

The general level of yield from this trial was very high, the variety Co.419 has outyielded at the 5 per cent level all varieties listed below Co.312.

N.Co.339 is a new variety to Nyanza trials and has done very well. Co.331 which is the variety recommended for planting at the present time has also yielded well, although the low sucrose yield should be noted.

SUGAR CANE FERTILIZER TRIAL, MIWANI

The plant crop of this trial was reported on in 1955 when there were no significant responses to sulphate of ammonia, double superphosphate or muriate of potash. The fertilizers were reapplied to the 1st ratoon crop at the following rates:—

(a) Sulphate of ammonia at nil, 280 lb. and 560 lb. per acre.

(b) Double superphosphate at nil, 120 lb. and 240 lb. per acre.

(c) Muriate of potash at nil, 120 lb. and 240 lb. per acre.

Fertilizers were applied in shallow drills six inches from the cane stools on each side of the rows. Cane variety is Co.281.

The 1st ratoon was harvested in February 1956.

The analysis showed a response to sulphate of ammonia at the 1 per cent level, a small non-significant response to increasing phosphate applications and a similar situation held for potash. There were no significant interactions. Yield figures are given below in tons of cane per acre:—

Sulphate of Ammonia	Yield	Double Supers	Yield	Muriate of Potash	Yield
<i>lb./acre</i>		<i>lb./acre</i>		<i>lb./acre</i>	
560	37.60	240	36.58	240	36.90
280	38.05	120	35.46	120	35.58
Nil	31.25	Nil	34.83	Nil	34.39
Mean ..	35.62		35.62		35.62

LEAST SIG. DIFF.—

P=0.05 2.22

P=0.01 3.02

The apparent significant difference in the muriate of potash column did not show up in the "F" test of the analysis of variance.

MOLASSES AND FILTER PRESS MUD EXPERIMENT ON SUGAR CANE, MIWANI

The plant crop of this experiment was fully reported in 1955; the 1st ratoon crop was harvested in December. No treatments were applied to this crop in order to test any possible residual effects from the original treatments.

In the 1st ratoon crop there were no significant residual effects to any treatment combination. Yield figures are given below in tons of cane per acre:—

Treatment	Yield	Treatment	Yield	Treatment	Yield
N6	28.81	N6M	30.62	N6F	30.27
N3	29.14	N3M	28.39	N3F	29.16
No ..	27.41	NoM	28.03	NoF	27.82
Mean ..	28.45		29.01		29.08

Figures for significance levels are not given as the "F" tests in the analysis of variance failed to reach significance.

SUGAR CANE DRAINAGE OBSERVATION TRIAL, OKOK (E. KONYANGO)

In 1954 an observational trial was laid down in the East Konyango location of South Nyanza to test the effect of various simple drainage works in an area thought suitable for block plantings of sugar cane by Africans.

The variety of cane planted was Co.421 and this was harvested in 1956. Treatments and yield figures in tons of cane per acre are given below:—

<i>Treatment</i>						<i>Yield</i>
12 ft. ridges and furrow	..	..	..	..	..	65.6
18 ft. ridges and furrow	..	..	..	..	..	61.2
6 ft. ridges untied	..	..	..	..	..	64.3
6 ft. ridges tied	..	..	..	..	..	62.4
Flat	..	..	..	..	..	56.7
						—
Mean						62.6
						—

Yield figures are generally very high but the value of a simple wide ridge and furrow may clearly be seen.

M. E. H. VICKERS,
Agricultural Officer (Experiments), Nyanza Province.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), RIFT VALLEY PROVINCE, 1956

Introduction

The programme of experimental work for 1956 was a large one, and was carried out on the Experimental Farms at Ol Joro Orok (7,800 ft.), Eldoret (7,000 ft.) and Kitale (6,200 ft.), as well as on the departmental plots at Rongai (6,100 ft.) and Njoro (7,100 ft.), and on co-operating farms in all districts.

Briefly the work done consisted of investigations into the manurial and drainage requirements of vlei soils; the use of fertilizers on grass and arable crops; the performance of various fodder and silage crops; grass species for leys, and ley-establishment; maize spacing; soil fertility; weed control; the decline in baking quality of Kenya wheats; and the feeding and management of stock. The results of cereal observational and varietal trials undertaken for the Senior Breeder appear in his Annual Report.

The work done by the Entomologist (R.V.P.), based at Nakuru, is reported in the Annual Report of the Senior Entomologist.

Weather

The total rainfall was slightly below average at Kitale but above average at the other centres. All districts experienced abnormal rains in the early months of the year which affected preparations for planting to some extent. Hail caused considerable damage to crops in the Kitale area. With the drier spell at the end of the year conditions for harvesting were satisfactory.

Comparative rainfall figures are as follows:—

	1954	1955	1956
Nakuru	42·80	37·58	39·54
Kitale	47·90	40·12	45·01
Eldoret	38·13	39·79	43·95
Ol Joro Orok	36·79	35·28	40·96
South Kinangop	Not available		42·10
Njoro	46·48	38·92	42·31
Rongai	45·08	25·36	39·76

Experimental Work

Experiments reported here are those which, to date, have produced useful information.

Nakuru District

DRAINAGE

The mole-draining trial on a Londiani vlei soil was continued with wheat in 1956. The trial consisted of six blocks, each block having one mole-drained plot and one undrained plot, with the plots alternating in one continuous line. The plot size was 0.275 acre.

The moles were inspected in January, 1957, and were seen to be in good condition, considering that the experimental area had been cropped with wheat for six years, but the outlets had deteriorated.

The moled plots have given a higher yield than the unmoled plots, the difference of 0.83 bag/acre being significant at 1 per cent point.

RESULTS

MEAN YIELD	Moled	Unmoled	SIG. DIFFERENCE	
			5 per cent	1 per cent
lb./plot	288.0	242.3	12.34	19.35
bags/acre	5.23	4.40	0.22	0.35
Per cent of Mean	108.6	91.4	4.6	7.3

The yields of wheat have been dropping since the peak in 1954 as the following figures (bags/acre) show:—

YEAR	Moled	Unmoled	Mean
1951	3.78	3.78	3.78
1952	4.97	5.30	5.13
1953	6.02	4.83	5.42
1954	8.89	7.52	8.20
1955	6.25	4.37	5.31
1956	5.23	4.40	4.81
Mean	5.86	5.03	5.44

SILAGE CROPS

Three maize/legume mixtures and maize alone were planted for silage at the Rongai Experimental Plots on 19/4/56 for comparison of green material yields and feeding value of the silage.

The treatments A Maize alone

B Maize plus Lima beans

C Maize plus *Dolichos lablab*

D Maize plus *Crotalaria intermedia*

were compared in a 4×4 Latin square, one replication, with a harvested plot size of 0.01579 acre.

On 19th April, 1956, the legumes were planted in the row with the maize which was spaced 2'×11" in the row. A dressing of 1 cwt. of Supers per acre was given to every plot.

It was observed early on that the Lima bean grew too fast for planting at the same time as the maize, but the *Dolichos*, followed by the *Crotalaria*, were less vigorous and competitive. The maize suffered considerably due to the competition of the Lima bean, but this mixture eventually gave the highest yield per acre mainly because of the great bulk of beans.

One-third of each treatment was cut at the tasselling stage, at the milky-cob stage, and at the doughy-cob stage, the cut material weighed in each plot and a random sample taken from each of the four plots in each treatment and ensiled in 44-gallon drums—one drum per treatment for each stage.

Summary of yields in tons per acre of green material:—

TREATMENTS	A	B	C	D	Mean	
(1) Tasselling stage ..	19.16	17.39	18.17	17.42	18.03	S.D. 1.34 (P=0.05) 1.81 (P=0.01)
(2) Milky-cob stage ..	17.40	18.36	16.03	16.68	17.12	
(3) Doughy-cob stage	8.50	12.77	9.86	8.62	9.94	
Mean	15.02	16.17	14.69	14.24	15.03	S.D. for body of table 2.68 (P=0.05) 3.63 (P=0.01)
S.D. 1.86 (P=0.05) 2.81 (P=0.01)						

The differences between the treatments in the first two cuts were not significant. Maize alone grew best initially, no doubt because it was free from legume-competition, and yielded the highest in the first cut. In treatments B, C and D the maize suffered from legume-competition, but the weight of leguminous material was not sufficient to off-set the reduced growth of the maize. As the maize matured and dried off the legumes gradually made their presence known; this is particularly apparent in treatment B where the Lima beans grew vigorously. The differences between maize/Lima bean and the other three treatments at the doughy-cob stage were significant ($P=0.05$), and over the three cuts this mixture emerged as the highest yielder, though not significantly so.

Samples of the made silage were analysed, with the following results which must be taken with some reserve because the samples were delayed in transit and the possibility of errors occurred during the analysis:—

Crude Protein as per cent of Dry Matter

	A Maize alone	B Maize Lima beans	C Maize <i>Dolichos</i>	D Maize <i>Crotalaria</i>
(1) Tasselling stage ..	8.11	10.05	7.12	9.33
(2) Milky-cob stage ..	6.76	10.06	8.17	5.29
(3) Doughy-cob stage ..	9.08	12.73	10.63	8.63

The analysis showed that the Maize/Lima beans silage contained the highest percentage of crude protein at all three stages, but it is unlikely that the doughy-cob stage of any one of the mixtures would be considered for silage with such a low yield of cut material per acre.

The Maize/Lima beans mixture would appear the most worthwhile silage crop of the four, as far as yield and feeding value are concerned, and could be cut either at the tasselling or milky-cob stages, with a slight preference for the latter.

MAIZE

A trial to determine the effect of nitrogen, row spacing, plant population, and interplanted legume on maize was repeated for the second year on the farms of H. H. Kjaertinge, Rongai (6,100 ft.), and C. J. Curtis, Kampi-ya-Moto (5,900 ft.), with a new site on the farm of F. Ellvers, Elburgon (7,900 ft.).

The treatments and design were identical at all three sites, the treatments being:—

Time of application of Nitrogen N_0 = Nil

N_1 = at sowing

N_2 = at knee-height

N_3 = half at sowing, half at knee-height

Spacing between rows S_1 = $3\frac{1}{2}$ ft.

S_2 = $6\frac{1}{2}$ ft.

Interplanted legume L_0 = No legume

L_1 = Legume

Plant population P_1 = 10,000 plants/acre

P_2 = 14,000 plants/acre

—giving at $4 \times 2 \times 2 \times 2$ confounded factorial trial with one replication. The plot size was 0.0567 acre (including guard rows). A basal dressing of $1\frac{1}{2}$ cwt. Double Supers per acre was given to the whole experiment and the Nitrogen top-dressing was given as sulphate of ammonia at 2 cwt./acre. The legume planted was Lima bean.

(a) The maize in the Rongai trial was planted on 5th April, 1956, and harvested in November. The growth was good and yields were high, in a year when farm yields in the district were good. The mean yield was 24.4 bags per acre.

RESULTS

Summary of Main Effects

Treatment Means as	N_0	N_1	N_2	N_3	SIG. DIFF.
					5 per cent
lb./plot	117.3	117.1	129.7	124.5	15.6
bags/acre	23.4	23.4	25.9	24.9	3.1
Per cent of Mean	96.0	96.0	106.1	101.9	12.8

	S_1	S_2	P_1	P_2	L_0	L_1	SIG. DIFF.	
							5%	1%
lb./plot	136.7	107.7	120.4	124.1	125.2	119.2	11.1	15.7
bags/acre	27.3	21.5	24.1	24.8	25.0	23.8	2.2	3.1
Per cent of Mean ..	111.9	88.1	98.5	101.5	102.4	97.5	9.1	12.8

Differences between the yields due to Nitrogen were not significant but, as in 1955, there was a definite indication that maize responds more to Nitrogen applied at knee-height. 14,000 plants per acre gave a higher yield than 10,000 and the plots without the interplanted legume yielded better than those with the legume, but the differences were not significant.

The $3\frac{1}{2}$ feet row spacing gave a significantly ($P=0.01$) higher yield, by 5.8 bags per acre, than the $6\frac{1}{2}$ feet row spacing but the superiority of the narrow spacing in a year of good rainfall should be accepted with caution. In 1955 when the rainfall was only 25 inches the positions were reversed.

(b) The maize in the Kampi-Ya-Moto trial was planted on 17th April, 1956, harvested on the 25th October, and gave the highest mean yield, 26.8 bags/acre, of the three trials.

RESULTS

Summary of Main Effects

Treatment Means as	N ₀	N ₁	N ₂	N ₃	SIG. DIFF.
					5 per cent
lb./plot	130.6	134.0	138.3	132.9	14.8
bags/acre	26.1	26.8	27.6	26.6	2.97
Per cent of Mean	97.9	100.4	103.6	99.6	11.1

	S ₁	S ₂	P ₁	P ₂	L ₀	L ₁	SIG. DIFF.	
							5%	1%
lb./plot	144.4	123.4	133.8	134.0	130.4	137.5	10.6	14.9
bags/acre	28.9	24.7	26.8	26.8	26.1	27.5	2.11	2.98
Per cent of Mean ..	108.2	92.5	100.2	100.4	97.7	103.0	7.9	11.2

There were no significant differences between yields due to Nitrogen, interplanted legume, or population, but Nitrogen applied at knee-height gave a slightly higher yield. The $3\frac{1}{2}$ feet row spacing yielded 4.2 bags per acre more than the wide spacing (significant $P=0.01$).

(c) The Elburgon trial, planted on 24th April, 1956, was the most backward and uneven of the three and the last to be harvested, on 31st December. The mean yield was 19.4 bags per acre.

RESULTS

Summary of Main Effects

Treatment Means as	N ₀	N ₁	N ₂	N ₃	SIG. DIFF.
					5 per cent
lb./plot	100.1	97.3	94.9	96.3	18.2
bags/acre	20.0	19.5	19.0	19.3	3.63
Per cent of Mean	103.1	100.2	97.7	99.1	18.7

	S ₀	S ₁	P ₁	P ₂	L ₀	L ₁	SIG. DIFF.	
							5%	1%
lb./plot	107.5	86.8	90.3	103.9	105.3	89.0	12.8	18.3
bags/acre	21.5	17.3	18.0	20.7	21.0	17.8	2.56	3.66
Per cent of Mean ..	110.7	89.4	93.0	107.0	108.4	91.6	13.2	18.8

The peculiar responses to nitrogen are attributed to the fact that the plots with the poorest stands, and consequently poorest yields, came into the treatments receiving N_2 and N_3 . Particularly bad germination was the reason for the poor stands in these plots and it was not possible even by judicious thinning to make up for the missing plants.

The $3\frac{1}{2}$ feet row spacing outyielded the $6\frac{1}{2}$ feet spacing by 4.2 bags per acre, the difference being highly significant ($P=0.01$). The 14,000 plants/acre population was just significantly better than 10,000 plants/acre by 2.7 bags per acre ($P=0.05$), while the plots with no legume interplanted yielded 3.2 bags per acre more (significant $P=0.05$) than those with interplanted legume.

Ol Joro Orok

FODDER CROPS

Seven varieties of fodder beet were grown in unreplicated plots on the Experimental Farm for yield observations. The rows were 22 inches apart and the plots size 0.056 acre.

Double superphosphate at the rate of $1\frac{1}{2}$ cwt. per acre was applied at planting, with a later top-dressing of 1 cwt. sulphate of ammonia per acre.

The beet was sown on 12th July, 1956, singled on September 6th, and harvested on 27th January, 1957, with the following results:—

VARIETY	Yield in tons/acre
Brenstedt	32.25
Pajberg Rex (var. X)	17.20
Barre's Stryno	16.45
Jaapjes Groenkraag Groeningia	14.20
Yellow Otufte	14.05
Hunsballe	13.35
Rex	11.05

The above varieties and new varieties will be tested further in 1957.

WEEDS

A spraying trial to test the effectiveness of three herbicides in controlling *Coleus* spp. in a natural Star grass pasture was undertaken in 1955 on the farm of Col. W. F. A. Gossage, Naivasha.

The treatments were:—

'Agroxone' 4	@ 4 pints per acre
Fernimine	@ 3 pints per acre
Finopal	@ 4 pints per acre
Two controls	

The sprayed plots, $\frac{1}{2}$ acre in size, were replicated twice, and half of each plot was mown.

The *Coleus* was sprayed on 24th August, 1955, when it was in flower, and the Star Grass seeding.

Scoring of the plots periodically indicated that all the herbicides were effective, and after three months all equally so. Some slight regrowth took place in all plots. The unseasonal rains towards the end of 1955 helped to boost the Star grass and it quickly covered the ground left bare by the killing of the weed. It was observed that the effectiveness of the herbicides was increased when mowing and carting off the *Coleus* tops was followed by spraying new growth 3-4 weeks afterwards.

The kill was about 90 per cent without cutting and over 95 per cent after cutting and carting off.

"Agroxone" 4 at three pints per acre was also tried and found to be just as effective as four pints. Following this trial both "Agroxone" 4 and Fernimine were used on a field scale, the total area sprayed being 40 acres. For reasons of expense Finopal was not included.

Observation of the spray treatments continued in 1956, and later grazing control was added to the treatment of the 40 acres.

The spraying and resting was wholly successful and a flourishing, robust, Naivasha Star grass (*Cynodon plectostachyum*) pasture was restored.

ANIMAL HUSBANDRY

Beef

On the Experimental Farm the trial to compare Hereford x Boran, Aberdeen-Angus x Boran, and Boran steers, being fed similarly, continues.

All the animals in the trial were born in the period August-December, 1954, the calvings being rather widely spaced for strict comparison.

The animals have been weighed weekly. It was observed that—

- (a) in periods of high rainfall and low temperature liveweight gain was *low*.
(b) in periods of lower rainfall and higher temperatures liveweight gain was *high*.

e.g. (a) June, July and August in 1956 were wet and cold.

In a 14-week period when 19 in. of rain fell:—

Hereford × Boran gained a *total* of 6 lb.

Aberdeen-Angus × Boran gained a *total* of 24 lb.

Boran gained a *total* of 32 lb.

(b) September, October and November in 1956 were warm and dry. In a 12-week period:—

Hereford $\times$ Boran *averaged* 15 lb. per week gain/beast

Aberdeen-Angus × Boran *averaged* 12.5 lb. per week gain/beast

Boran *averaged* 8.6 lb. per week gain/beast

The first steer to be slaughtered, on 29th November, 1956, was a Hereford $\times$ Boran born in August, 1954. Weighing 1,046 lb. liveweight it killed out at a fraction under 50 per cent, and was Grade I.

The weights of the remaining beasts at 11th December, 1956, were as follows:—

CROSS	No. in group	Age	Average weight
			<i>lb.</i>
Hereford x Boran	2	2 years 3 months	790
Hereford x Boran	4	2 years 2 months	850
Hereford x Boran	2	2 years 1 month	792
Hereford x Boran	4	2 years	774
Aberdeen-Angus x Boran..	12	2 years 2 months	771
Boran	8	2 years	584

Feeding with oats commences at 920 lbs. liveweight.

Pigs

A long-term comparison of creep feeding with normal feeding of piglets to weaning was completed during 1956.

Beginning with litters born in October and November, 1953, the comparison has been conducted since then using every sow and all litters on the Experimental Farm. The majority of the litters were the offspring of the Large White boar $\times$ Wessex Saddleback sow cross and the remainder the off-spring of the Large White $\times$ (Large White $\times$ Wessex Saddleback) cross.

The creep feed was composed of 67 per cent barley and 33 per cent meat meal.

An examination of the recorded data showed that in every case where creep feeding was used the weight at weaning exceeded that where normal feeding was practised, in some cases to a marked degree.

Further information was obtained from the records of the pigs until they were slaughtered at 200 lb. liveweight as follows:—

- (1) Creep feeding reduced the average disposal age from 28.08 weeks to 24.10 weeks.
- (2) Creep feeding reduced the average conversion ratio from 3.8 to 3.2.
- (3) The average profit per pig sold at 200 lb. liveweight was increased by Sh. 17/97 by creep feeding.

Eldoret

FERTILIZERS

The experiment to determine the cumulative and residual effects of three types of phosphatic fertilizer, started in 1952 on the Experimental Farm, continued in 1956.

The following treatments were tested in a 10×10 Latin square:—

- (a) Control—no phosphate.
- (b) Uganda rock phosphate applied in the first year only.
- (c) Uganda rock phosphate in first and second years.
- (d) Uganda rock phosphate in first, second and third years.
- (e) Soda phosphate in first year only.
- (f) Soda phosphate in first and second years.
- (g) Soda phosphate in first, second and third years.
- (h) Double supers in first year only.
- (i) Double supers in first and second years.
- (j) Double supers in first, second and third years.

The rates applied annually were: double supers (40.8 per cent citric soluble P_2O_5) at 206 lb., soda phosphate (18 per cent) at 466 lb. and Uganda rock (3.6 per cent) at 816 lb., all per acre.

1956 was the second year in which no fertilizers were applied, the effects therefore being purely residual.

Canadian Regent wheat was sown on 5/6/56 and harvested on 17-21/12/56. Yields were very low although slightly better than those of 1955.

Summary of 1956 yields

TREATMENT MEANS	(1)	UGANDA ROCK				SODA PHOSPHATE			DOUBLE SUPERS		
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	
(1) lb./plot	3.29	4.87	5.75	6.34	5.79	5.93	7.26	4.47	6.71	7.11	
(2) bags/acre. . .	0.99	1.47	1.74	1.92	1.75	1.79	2.20	1.35	2.03	2.15	
(3) Per cent of Means	57.2	84.7	100.0	110.3	100.7	103.1	126.3	77.7	116.7	123.6	

				SIG. DIFFERENCE	
				5 per cent	1 per cent
(1)	..	..		1.06	1.40
(2)	..	..		0.32	0.42
(3)	..	..		18.4	24.3

There were no significant differences between the three fertilizers applied over two or over three years but double supers and soda phosphate maintained their lead over Uganda rock phosphate.

Applied in the first year soda phosphate was significantly better (5 per cent) than double supers, but not better than Uganda rock.

Taking the fertilizers separately it is noted that the three year and two year applications of double supers were both significantly better than the one year application at the 1 per cent level.

Soda phosphate applied over three years was 1 per cent significantly better than the one year application and also was 5 per cent significantly better than soda phosphate applied over two years.

Uganda rock applied over three years was 1 per cent significantly better than the one year application. The other differences were not significant.

Except for double supers applied in the first year all other phosphate treatments were significantly better (1 per cent level) than the control.

ANIMAL HUSBANDRY

A calf-rearing trial was carried out to completion on the Experimental Farm during 1956.

One group of calves was reared on Whole milk, and one group on Milk Substitute (Unga Cream Equivalent—mixed with skim according to the instructions). The other feeds, including concentrates (calf-rearing meal) and silage, were the same for both groups.

There was no marked difference between the final weights of the two groups at 13 weeks old. The cost of the Whole milk alone was Sh. 113/69, and the cost of the Unga Cream Equivalent (inclusive of skim) was Sh. 52/33. It must be borne in mind that these figures do not represent the total cost of rearing the calves in each group, as they do not include the cost of the other feeds, nor of housing and labour, these being the same for each group.

Kitale

FERTILIZERS

A trial to compare the effect of several phosphatic fertilizers on maize was laid down on the farm of Mr. A. C. Wilson, Kitale, the site being a different one from that of the 1955 phosphate trial on the same farm. The treatments, altered slightly, were tested in a 6×6 Latin square with one replication.

The maize was planted on 10/5/56 and harvested on 7/2/57.

The treatments and a summary of the yields were as follows:—

TREATMENTS	Mean Yield lb./plot	Mean Yield bags/acre
0.66 cwt./acre P_2O_5 as Double supers	117.4	15.71
0.33 cwt./acre P_2O_5 as Double supers	114.3	15.29
0.50 cwt./acre P_2O_5 as Basic slag	100.00	13.38
0.50 cwt./acre P_2O_5 as Soda phosphate	97.5	13.04
Control—no phosphate	91.2	12.20
1 ton/acre Uganda rock phosphate	86.5	11.57
Significant difference between 2 treatment means—		
P=0.05	19.9	2.66
P=0.01	26.9	3.60

Comparing the four highest-yielding treatments the difference between 0.66 cwt./acre P_2O_5 as double supers and 0.50 cwt./acre P_2O_5 as soda phosphate was only just significant at the 5 per cent level.

Both the double supers treatments were significantly better than the control at the 5 per cent level and highly significantly better than the Uganda rock phosphate treatment at the 1 per cent level.

Other differences were not significant.

MAIZE

The experiment to determine the effect of nitrogen, row spacing, plant population, and interplanted legume on maize was repeated for the second year on the Experimental Farm as a $4 \times 2 \times 2 \times 2$ confounded factorial with two replications, the treatments being:—

Time of application of nitrogen at

2 cwt./acre N_0 =Nil

N_1 =at sowing

N_2 =at knee-height

N_3 =half at sowing, half at knee-height

Spacing between rows S_1 =3½ ft.

S_2 =6½ ft.

Plant population P_1 =10,000 plants/acre

P_2 =14,000 plants/acre

Interplanted legume L_0 =No legume

L_1 =Legume—*Dolichos lablab* at 20 lb./acre between the maize rows.

A basal dressing of $1\frac{1}{2}$ cwt. double supers per acre was applied to the whole experiment.

The maize was planted on 19th April, 1956, and harvested early in January, 1957. The growth was satisfactory and a response to nitrogen was observed visually quite soon after application.

Some of the plants were laid by storms. A count of fallen plants prior to harvest showed that nearly twice as many plants fell in the higher population than in the lower. The application of nitrogen appeared to aggravate the fall of plants.

Summary of main effects

Treatment Means as	N ₀	N ₁	N ₂	N ₃	SIG. DIFF.	
					0.05	0.01
lb./plot	107.44	113.20	124.87	113.32	7.42	9.75
bags/acre	18.95	19.96	22.02	19.99	1.31	1.72
Per cent of Mean ..	93.7	98.7	108.9	98.8	6.5	8.5

Treatment Means as	S ₁	S ₂	P ₁	P ₂	L ₀	L ₁	SIG. DIFF.	
							0.05	0.01
lb./plot	121.13	108.28	115.11	114.31	116.39	113.02	5.25	6.90
bags/acre	21.36	19.10	20.30	20.16	20.53	19.93	0.93	1.22
Per cent of Mean ..	105.6	94.4	100.3	99.6	101.5	98.5	4.6	6.0

Applying nitrogen at the knee-height stage (N₂) has resulted in significantly (1 per cent) higher yields than any of the other three nitrogen treatments, the increase over no nitrogen being 3.07 bags/acre.

The narrow row spacing gave a higher yield than the wide spacing, the difference of 2.26 bags/acre being highly significant (1 per cent).

Other differences and interactions were not significant.

J. W. REID,
Assistant Agricultural Officer (Experiments), Rift Valley Province.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), CENTRAL PROVINCE, 1956

Rainfall

	EMBU		MOLINDUKO		KANJA	
	Inches	Days	Inches	Days	Inches	Days
January ..	3.66	14	2.03	12	2.72	7
February ..	0.22	2				
March ..	1.66	9	0.73	7	4.09	5
April ..	24.54	24	12.68	21	38.50	20
May ..	3.03	16	2.73	7	8.875	20
June ..	0.82	9	0.15	3	1.75	14
July ..	0.90	15			1.186	19
August ..	1.03	15	0.56	10	1.67	18
September..	0.94	7	0.45	2	1.14	12
October ..	1.79	11	1.05	4	5.25	12
November..	9.40	15	5.47	13	9.13	25
December..	0.91	7	0.58	5		
Total ..	48.70		26.43		74.311	

The Short Rains 1955 continued into January. The Long Rains were rather late and badly distributed. 24.54 inches fell in 24 days in April. The 40-year average for the entire long rains is 23 inches. Very little rains fell in May. The Short Rains were on time and of good distribution.

Reports on Experimental Work

(1) HIGH BRACKEN ZONE

Fertilizer and Farmyard Manure trial.—The object of this trial was to test the effects of phosphate at $1\frac{1}{2}$ cwt. per acre versus nil, sulphate of ammonia at 3 cwt. per acre versus nil, muriate of potash at 2 cwt. per acre versus nil, magnesium sulphate at $2\frac{1}{7}$ cwt. acre versus nil and farmyard manure at 15 tons per acre versus nil on a Long Rains planted crop of English potatoes. The layout was one replicate of a 2^5 factorial.

TABLE OF RESULTS.—YIELDS IN 180-LB. BAG PER ACRE

	Nil	Magnesium	Phosphate	Magnesium-Phosphate
No Farmyard Manure ..	33.8	29.3	64.2	69.8
Farmyard Manure ..	138.2	129.8	128.0	140.2

Each of the above figures is the total yield in bags per acre of the relevant sites of four plots. L.S.D. is based on the differences between the yields of sixteen plots totals.

L.S.D. at 1 per cent level of $t=7.5$ bags/acre.

L.S.D. at 5 per cent level of $t=5.4$ bags/acre.

The outstanding feature of the results is the overwhelming responses to farmyard manure at 15 tons/acre which practically doubled the yield. Superphosphate was the only individual fertilizer to give a response.

(2) STAR AND KIKUYU GRASS ZONE

Exploratory Fertilizer trial.—This experiment was started at Embu in 1952 as an initial investigation of fertilizer responses on the Embu Investigation Station farm. Treatments were sulphate of ammonia at 0, 1 and 2 cwt. per acre, double superphosphate at 0, 1 and 2 cwt. per acre, muriate of potash at 0, $\frac{1}{2}$ and 1 cwt. per acre combined in two replications of a 3^3 factorial layout, N.P.K. confounded. Due to the repeated failure to obtain a potash response on this Station, in 1956 the muriate of potash treatments were changed to the time of broadcast under-sowing Rongai Rhodes grass. K_0 =16 days after maize planting K_1 at 1st weeding (42 days after sowing), K_2 =2nd weeding (62 days). Other treatments reapplied.

SUMMARY TABLE OF MEANS
Yields in lb. Dry Maize Grain per Acre

			P ₀	P ₁	P ₂	K ₀	K ₁	K ₂	Mean
N ₀	..	..	600	1,044	1,684	868	1,448	1,012	912
N ₁	..	..	1,340	2,096	2,460	1,608	2,220	2,064	1,964
N ₂	..	..	1,356	1,916	2,392	1,696	1,876	2,020	1,880
Mean	..		1,096	1,684	2,180	1,392	1,872	1,700	

				K ₀	K ₁	K ₂
P ₀	..	..	1,248	764	1,280	
P ₁	..	..	1,372	1,988	1,692	
P ₂	..	..	1,556	2,860	2,124	

L.S.D. at 5 per cent level of $t=548$ lb. }
 1 per cent level of $t=736$ lb. } Between marginal means

The "F" test shows significant differences between the main effects of N and P only, confirming the previous years results. In 1955 the response to both levels of nitrogenous fertilizer was at the 5 per cent level. In 1956, it was at the 1 per cent level. There were no significant differences within treatments. Due to the poor distribution of rainfall, the time of sowing treatment analysis on sample cuts of grass merely showed that when rain falls in adequate quantities, grass will grow. There were no significant differences due to fertilizer application to the arable crop.

Phosphate and Farmyard Manure trial.—This was originally laid down as a Ridging, Mulching and Farmyard Manuring trial in 1952. In 1955, the ridging treatment was replaced by the reapplication of 5 tons farmyard manure per acre versus nil, the mulching treatment replaced by 1 cwt. per acre double superphosphate versus nil and the original farmyard manure treatment of 5 tons annually was left for residual versus nil. The layout was a 2^3 factorial, in blocks of four plots with two blocks per replication and four replications second order interaction confounded.

2×2 TABLE OF TREATMENT MEANS
Yields of Dry Maize Grain in lb. per acre

	Phosphate	No Phosphate	Mean
Residual FYM	3,449.5	3,146.0	3,297.5
No Residual FYM	2,926.5	2,720.5	2,823.5
Reapplied FYM	3,301.0	3,162.5	3,231.5
No Reapplied FYM	3,075.0	2,704.0	2,889.5
Mean	3,188.0	2,933.0	3,060.5

	Reapplied FYM	No Reapplied FYM	Mean
Residual FYM	3,490.0	3,105.5	3,297.5
No Residual FYM	2,973.5	2,673.5	2,823.5

L.S.D. between marginal means at 5 per cent level=469.7 lb.

1 per cent level=643.5 lb.

L.S.D. in body of the table at 5 per cent level=663.9 lb.

1 per cent level=909.4 lb.

The "F" test showed no significant differences.

The "t" test showed that Residual FYM outyielded No Residual at the 5 per cent level.

Note.—A basal dressing of 1 cwt. double superphosphate was applied to all plots. Thus the difference between Phosphate and No Phosphate in the above Table is not directly comparable with previously published results.

Coffee Variety trial, Kangaru.—This trial was planted in 1950 to test five varieties of arabica coffee at the lower edge of the optimum zone for coffee growing in Embu district (4,800 feet A.S.L.). The design is a 5×5 latin square with nine trees per plot at 9 ft. × 9 ft. spacing on mulched box ridges without shade. Yields are recorded by the calendar year.

1956 RESULTS

VARIETY	Yield in lb. Cherry per acre	Percentage
SL.34	9,132	114
SL.28	9,027	113
SL.14	7,589	95
Kents	7,300	91
N197	6,892	86
Mean	7,988	100

L.S.D. at the 5 per cent level=1,371 lb. or 17 per cent

1 per cent level=1,922 lb. or 24 per cent.

It will be noted that at a 6:1 cherry to clean coffee ratio, the mean yield is 11.9 cwt. per acre clean coffee.

(3) GRASS WOODLAND ZONE

Experiments were resumed in 1955 with the easing of the Emergency situation. Trials are still in the preliminary stage.

An observation on seventy-five varieties of groundnuts showed promising results, Gambia Bunch and A.H.32 yielding over 2,000 lb. per acre shelled nuts from a 10-yard ridge.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), SOUTHERN PROVINCE, 1956

Weather

The Short Rains, 1955, were prolonged into the early months of 1956 and some difficulty was experienced due to rain at harvest time. The Long Rains, 1956, failed and no maize was harvested except in certain hill districts. The Short Rains, 1956, were exceptionally heavy at Kampi ya Mawe and slightly above average for Makaveti and Katumani.

TOTAL RAINFALL FOR THE YEAR

Katumani	..	..	..	9.72" (Oct., Nov., Dec. only)
Kampi ya Mawe	..	..	..	35.87" in 74 days
Demonstration Holding	..	..	..	32.08" in 75 days
Makaveti	..	..	..	25.27" in 60 days

Development of the New Station at Katumani

The main development in the Southern Province has been the establishment of a new research station, Katumani Experimental Farm, six miles from Machakos. Work has continued at Kampi ya Mawe (Makueni), and at Makaveti, and exploratory fertilizer trials have been done on different soil types in the African areas. It had been felt for some time, however, that experimental work in the Province had suffered from being diffused over too wide an area. Changes of staff caused a lack of continuity and the only permanent site for research, Kampi ya Mawe, has suffered from lack of a permanent water supply, lack of housing on the site and inaccessibility. The establishment of Katumani Experimental Farm was designed to overcome these difficulties.

Katumani farm was taken over by the Department in October, 1955. It lies six miles S.S.E. of Machakos at an altitude of about 5,400 ft. The nearest rainfall station about two miles away has recorded an average of 24.15 in. over 35 years. The vegetation consists of a fairly thick cover of trees and bush, mainly *Acacia* species, and a mixed grass sward dominated by Red Oat grass, Star grass, Bamboo grass (*Pennisetum mezianum*), *Cenchrus ciliaris* and *Eragrostis superba*. The soil varies from the red sandy loam which characterizes much of the district, to a rather sandier loam which is not so common.

Although the farm is higher and cooler than a large part of the semi-arid areas, the rainfall is certainly marginal for cropping and the sward contains most of the important grass species found in other parts. This, with the added advantage of proximity to Machakos and Nairobi, makes Katumani the most suitable available centre for research in the Province. Work done there should be relevant to a wide area of African and European farming which is not at present served by a research station though results will have to be tested out in the various ecological zones.

When Katumani was taken over there had been very little development and during 1956 work was concentrated on bush clearing, fencing and building. By the end of the year about 50 acres had been cleared and about 35 acres ploughed. A Pasture Research Officer, Plant Breeder and Farm Manager had been posted to the Station, and houses, stores, offices and laboratories had been built.

The Long Rains failed and from the 31st October to the end of December there were 9.72 inches of rain. Land that was ploughed during the dry season was planted to maize and beans in the Short Rains to give some indication of uniformity in preparation for laying down experiments during the 1957 Long Rains.

During the year numerous soil pits were dug and the farm was surveyed and mapped, 150 out of a total of 650 acres were found to be suitable for cultivation. The original herd of grade Ayrshires was reduced to 10 milking cows and followers, so that Zebu steers can be bought in when the grazing experiments start.

The main lines of future work at the Station can be divided into three groups: general crop research, plant breeding and pasture research. It is hoped to investigate methods of maintaining and improving soil fertility and to find what use can be made of leys in dry areas. An attempt will be made to breed faster-maturing varieties of maize and sorghum and work will be done to find the most suitable spacings. The best methods of managing natural grassland and controlling bush and the use of fodder crops and fodder conservation will be examined.

Kampi ya Mawe Sub-station

Most of the work has been with fertilizer experiments. An experiment to study the effect of nitrogen, phosphate and potash was started in 1952. No response has been shown to potash. Nitrogen was effective only in the presence of phosphate, and even then the response was not economic. However, the response to both 1 cwt. and 2 cwt. of phosphate was striking and definitely economic, and in the eighth season, when a crop of South African awned millet was planted, residual effects of the phosphate were still apparent.

An experiment to study the effect of double superphosphate in the presence and absence of manure showed that the response to phosphate was not significantly increased where manure had been applied at the rate of 10 tons/acre.

Work on cassava varieties received from Amani has shown that the variety "Msitu" was by far the highest yielder, palatable and resistant to mosaic disease.

Experiments with insecticides have shown the value of "Kynadrin" against harvester ants and termites. Using 2-3 pts. at 0.5 per cent concentration in water and spraying around and into the nest completely killed harvester ants. They could also be killed by baiting with Aldrin in maize meal. Spraying 1 per cent Kynadrin around and into termitaria also appears to be effective against termites.

Bush control experiments with arboricides have shown that 2 per cent Trioxone (2, 4, 5, T) in diesel oil when applied to mature *Acacia pennata* at one gallon of solution to 50 bushes is reasonably effective but costs are high. A lower concentration in water applied at a higher volume was also quite effective. Time of application may make a considerable difference and this will be investigated.

Makaveti Plots

During the 1955 Short Rains, half the original grazing experiment was ploughed out and the beans harvested in February, 1956, showed that natural veld gave the highest bean yields in the absence of former fertilizer applications.

while Star grass gave the highest bean yields where fertilizer had been applied in three previous years. *Panicum coloratum* var. *makarikariensis* gave the lowest bean yields with and without residual fertilizer effects.

On the grazing plots an attempt was made, based on a previous assessment, to maintain a stocking rate of one beast per two acres. However, owing to the failure of the Long Rains and fall in productivity of the leys this was found to be impossible without damaging the grass.

In general the most satisfactory grass cover has been obtained where a mixture of *Cenchrus ciliaris* and *Eragrostis superba* had been sown.

Exploratory Fertilizer Trials

Exploratory fertilizer trials were started during the Long Rains to investigate the response to nitrogen, phosphate, potash and manure on different soil types throughout the reserve. The Long Rains crop failed but the Short Rains crop should provide some useful results.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), COAST PROVINCE, 1956

Weather

The year was a poor one at all the experimental centres at the Coast except Shimba Hills where fair rainfall was experienced. Matuga was most affected by deficient rain, the total amount being only 25.32 in. Generally the failure in amount was, to a small extent, redeemed by good distribution in the Long Rains. Even at the worst-favoured centres fairly good short-term crops were obtained in these rains; the Short Rains were very poor at all centres except Shimba Hills.

Cassava

VARIETY TRIAL

In April, 1955, a new cassava variety trial was planted at Matuga. Six varieties were included, five being Amani hybrids, whilst Boto was again used as control. Of the five hybrids, 46106/26 had been the best variety in a previous full trial, whilst the other four, 46106/27, 4697/4, 46110/8 and 4763/16, had performed well in preliminary tests. The design of the experiment was a Latin square. Cultivation was on 5 ft. tied ridges. The varieties stayed in the ground for 13 months, being harvested in May, 1956. A total rainfall of 41 in. was very badly distributed so that drought persisted from July, 1955, until early January, 1956, was broken only briefly then, and no effective rain, as far as this crop was concerned, fell thereafter. Yields, as to be expected, were quite low. They are set out in Table 1.

TABLE 1.—YIELD OF CASSAVA ROOTS IN CWT. PER ACRE

46106/26	46106/27	Boto	4697/4	46110/8	4763/16	S.E.
88.1	58.1	62.9	82.3	59.6	56.2	±6.85

L.S.D. ($P=0.05$)=20.2.

Thus 46106/26 has again yielded well and is equalled only by 4697/4. All the Amani hybrids showed good resistance to mosaic compared with Boto, and 46106/27 and 4697/4 were quite free from this disease. All varieties remained free from Brown Streak, including Boto which is, in fact, fully susceptible.

RIDGING TRIAL

Again in April, 1955, a cassava ridging trial was laid out at Matuga in the form of a Latin square, using the variety 46106/26. 3 ft., 5 ft. and 6 ft. tied ridges were compared with flat cultivation. Two different spacings were used on 3 ft. ridges to give equivalent plant populations to the flat cultivation treatments on the one hand, and the 5 ft. ridge treatment on the other. The results are summarized in Table 2. Rainfall conditions were comparable to those described above for the variety trial. However, this trial continued until August which accounts for the generally higher yields. Rainfall for the whole 15-month period was 45.94 in.

TABLE 2.—(a) MEAN YIELDS OF ROOTS IN TONS PER ACRE AND (b) MEAN YIELD OF DRIED CHIPS IN CWT. PER ACRE

	(a)	(b)
A.—3 ft. ridges, spaced 3 ft. x 3 ft.	7.84	53.3
B.—3 ft. ridges, spaced 3 ft. x 5 ft.	8.10	55.9
C.—5 ft. ridges, spaced 5 ft. x 3 ft.	8.44	58.2
D.—6 ft. ridges, spaced 6 ft. x 3 ft.	7.78	53.9
E.—Flat cultivation, spaced 3 ft. x 3 ft.	6.95	48.4
S.E.	±0.47	±3.12
L.S.D. (P=0.05)	1.46	9.61

The 5 ft. ridges produced a significantly better yield than flat cultivation whereas the 6 ft. ridges, with a wider plant spacing, did not do so. The benefit from ridging was not generally so marked as was expected since markedly better growth was observed on the ridges in the early stages of the trial.

DATES OF PLANTING AND HARVESTING TRIAL

In a third trial with cassava the effects of different planting and harvesting dates on three varieties were examined. Comparison of April and July planting gave results markedly in favour of the later date when the crop was harvested after about a year in the ground. The April planted crop had good rains in the early stages of establishment and growth in April, May and June was excellent. Thereafter drought gave the crop a severe check. On the other hand the July planted crop had just sufficient rain for establishment, developed slowly without a definite check, and then obtained adequate rain for development in the later stages of growth, to give eventually as good a crop in 12 months as the April planted crop did in 16, and on a total of only 25 in. of rain compared with 53 in. for the earlier planted crop. When cassava was left in the ground for 18 months or more it appeared to matter less whether the crop was planted at the beginning of the Long Rains or in the July period.

Cotton

VARIETY TRIALS

In further variety trials at both the Cotton Research Station, Msabaha, and at Kibarani, the varieties UK48 and UK51 were compared with the variety N17. At the Cotton Research Station the variety 47/10 was also included in the trial. The same randomized block designs were used as in previous years. The germination and stand of all varieties were good. The usual pests and diseases were present without there being any particular varietal reactions to these to record except for resistance to Jassid. The order of resistance was very clear cut, except between UK51 and UK48, where a slight advantage in favour of UK51 appeared. Both the UK strains were markedly superior in resistance compared with N17, whilst 47/10 was even poorer in resistance.

Planting was rather late at both sites due to late arrival of the seed, and yields were consequently lighter than they could have been. Rainfall was 17.79 in. at the Cotton Research Station, Msabaha, and 19.46 in. at Kibarani. The results are summarized in Table 3.

TABLE 3.—MEAN YIELD OF SEED COTTON IN POUNDS PER ACRE

		UK51	UK48	N17	47/10	S.E.	L.S.D.	
							5%	1%
Msabaha	..	640	577	469	417	± 29.7	90	124
Kibarani	..	780	829	587	—	± 60.0	207	

Thus the difference in yield between the U.K. strains was not significant but both yielded better than N17 and 47/10. There were no significant differences between the varieties in the percentage of first grade cotton produced.

DATE OF PLANTING TRIAL

A cotton trial to test the effect of four different dates of planting on the cotton crop was laid out at the Cotton Research Station. The variety UK48 was used in this trial. The plots, of 1/20-acre size, were split for mulch and no mulch. The trial was in the form of randomized blocks. The four main treatments comprised planting (1) as early as possible at the beginning of the rains, (2) after some rain had fallen, (3) after considerable rain had fallen, and (4) late in the rains. Dried grass was used to make a complete mulch, the aim being to achieve a settled depth of 4 in., and to apply it about a week before planting. The mulch disappeared very quickly in the early stages of the trial and the cover was, in fact, less than an inch in thickness and very patchy for most of the growing period. By the middle of July it had in some cases almost disappeared.

The main results from this trial demonstrate the considerable advantage of timely planting. In addition to higher yields better quality cotton was obtained which greatly enhanced the profitability of early planting. Early planting appears to induce heavier Jassid damage but this is not a practical disadvantage when varieties of good resistance are available.

Mulching actually caused an overall depression in yields. It caused many gaps in the stand through termite damage but this was not the direct cause of lower yields. In the early stages of growth the crop under mulch was poor in colour and growth, i.e. appeared to be suffering from nitrogen starvation, and generally had a poor start. At a later stage of growth the colour of the mulched crop became much darker, presumably due to the release of nitrogen tied up through micro-organic activity in the rapid breakdown of the mulch in the early stages of growth. Nitrogen appeared to be excessive at this stage and caused delayed ripening. The consequence of this was a higher percentage of BR grade cotton. The presumption is that the bolls remained in an attractive condition for the stainers longer, thus producing a higher percentage of stained cotton. The main results are presented in Table 4.

TABLE 4.—MEAN YIELDS OF SEED COTTON IN POUNDS PER ACRE
(With Mean Percentages of AR Grade Cotton)

Date of Planting	Mulch	No Mulch	Means	Rainfall
7-4-56	636 (47)	909 (60)	773 (53.5)	27.00 in.
17-4-56	823 (46)	846 (60)	835 (53.0)	25.34 in.
30-4-56	454 (36)	643 (57)	549 (46.5)	20.79 in.
14-5-56	387 (21)	386 (35)	387 (28.0)	15.82 in.
Means ..	575 (37.5)	696 (53.0)		

MARGINAL MEANS

(i) S.E. of a "Date of Planting" mean = ± 40.6

L.S.D.	5%	1%	0.1%
	130	187	275

(ii) S.E. of the means of "Mulch" and "No Mulch" = ± 19.5

L.S.D.	5%	1%	0.1%
	60	84	119

TREATMENT MEANS

(iii) S.E. of "Mulch" and "No Mulch" means within the same planting date = ± 37.0

L.S.D. between these means	5%	1%	0.1%
	114	160	225

(iv) S.E. of a "Date of Planting" mean within the same "Mulch" or "No Mulch" treatment = ± 81.5

L.S.D. between means	5%
	183

MAIZE AND COTTON INTERPLANTING TRIALS

Randomized block trials, comparing maize and cotton planted in pure stands with maize and cotton interplanted, were continued during the year at Kibarani and the Cotton Research Station. The treatments were: (a) Plots divided, half sown to maize and half to cotton in pure stands, maize sown in early April. (b) Maize and cotton interplanted according to local custom, maize sown early April. (c) As in (b) but the maize sown late April. (d) As in (b) but the maize sown in early May. In all treatments cotton was planted at one time in early May.

At both sites the most conclusive result was again to demonstrate the necessity for early maize planting. At Kibarani half an acre of pure stand maize produced a yield not significantly different from that of an acre of early interplanted maize whereas the advantage was clearly in favour of the early interplanted maize at the Cotton Research Station. Again conflicting results came from the two trials for the cotton crop there being no significant differences at Kibarani between half an acre of pure stand cotton and one acre of interplanted cotton, whereas half an acre of pure stand cotton produced more than an acre of interplanted cotton at the Cotton Research Station. The main results are presented in Table 5.

TABLE 5.—MEAN YIELDS IN POUNDS PER HALF ACRE FOR TREATMENT (a), AND IN POUNDS PER ACRE FOR TREATMENTS (b), (c) AND (d)

Sites	Crop	(a)	(b)	(c)	(d)	S.E.	L.S.D.
Cotton Research Station ..	Maize grain	871*	1,301	1,164	590	± 122.2	390.2
	Seed cotton	281*	176	93	137	± 36.7	117.4
Kibarani	Maize grain	1,496*	1,709	1,388	1,129	± 128.1	410
	Seed cotton	348*	422	360	393	± 36.0	115

*Half acre yields only.

The Cotton Research Station site was of very patchy fertility so that the efficiency of the experiment was low at this site. At both sites the requirements of the experiment forced the planting date of cotton back too late, especially for this season when the rains were early curtailed, and thus the yields of cotton were low. These interplanting trials have run for several years and are now concluded. They have shown that the relative yields of pure stands and interplanting is very much a matter of site and season but the balance is in favour of pure stands especially in the light of the results of other trials which have demonstrated the necessity to plant cotton much earlier than was formerly believed to be the optimum date.

COTTON AND GROUNDNUTS INTERPLANTING TRIAL

A trial started in 1955 at Kibarani to compare pure stand cotton, pure stand groundnuts, and these crops interplanted, both on the flat and on 3 ft. tied ridges, continued in 1956. The design was randomized blocks with 1/40-acre plots. The full treatments were as follows: (a) Groundnuts on the flat, (b) groundnuts on 3 ft. ridges, (c) cotton on the flat, (d) cotton on 3 ft. ridges, (e) cotton and groundnuts, two rows of cotton alternating with four rows of groundnuts, on the flat, and (f) as in (e) but all on 3 ft. ridges. The growth of the groundnuts was very luxuriant and they offered severe competition to the cotton in the interplanted treatments. The cotton crop suffered from an unduly high proportion of shed bolls and staining, so that the percentage of first grade cotton was low reaching only 23 per cent.

The net income per acre for the treatments is given in Table 6, derived from 1956 prices of 40 cts. per lb. for shelled groundnuts, 54 cts. per lb. for first grade cotton, and 20 cts. per lb. for second grade. Groundnuts are shown to be generally more profitable than cotton due mainly to the low quality of the latter.

No advantage appears in this season from interplanting the crops, a result which is at variance with last season. The return from ridged cotton is better than from the flat planted crop but the difference is of doubtful significance.

TABLE 6.—MEAN GROSS RETURN PER ACRE (SH.)

TREATMENTS						
(a)	(b)	(c)	(d)	(e)	(f)	S.E.
511/72	481/36	344/30	433/07	423/94	464/42	±32/32

L.S.D. (at $P=0.05$)=97/39

COTTON VARIETY, SPACING, AND DATE OF PLANTING EXPERIMENT

A 3³ factorial trial was planted at the Cotton Research Station to compare UK48, UK51 and N17 planted at 3 ft.×1 ft., 3 ft. ×1½ ft. and 3 ft.× 2 ft. spacings, and at an early, medium and late date. In all cases the stand was thinned to two plants per hill. The results are presented in Table 7. This shows UK51 again as a good yielder, that variation in spacing within the limits of the experiment has no significant effect on yield, and that timely planting is important. There were no significant interactions.

This trial confirmed results from the variety trials with regard to Jassid damage. The amount of this depended on the time of planting and the variety. Early planted cotton was more severely attacked. The variety N17 is much more

susceptible to Jassid damage than UK48 or UK 51, the latter variety being appreciably more resistant than UK48. There was no significant effect of time of planting, spacing, or variety on the percentage of AR grade cotton produced.

TABLE 7.—MEAN WEIGHT OF SEED COTTON IN POUNDS PER ACRE

Variety		Spacing	Date of Planting
UK48	582	3 ft. x 1 ft. 645	24-4-56 732
N17	639	3 ft. x 1½ ft. 649	4-5-56 627
UK51	728	3 ft. x 2 ft. 621	14-5-56 589

S.E. = ± 40.7

L.S.D. between main effect means ($P=0.05$) = 123

COTTON RIDGING TRIAL

A cotton ridging trial, in the form of a Latin square with 1/40-acre plots, was planted at the Cotton Research Station. Cotton was planted (1) on the flat at 3 ft. $\times$ 1½ ft., (2) on 3 ft. tied ridges at 3 ft. $\times$ 1½ ft., (3) on 4½ ft. tied ridges at 4½ ft. $\times$ 1 ft., (4) on 4½ ft. tied ridges at 2¼ ft. $\times$ 2 ft. (two rows per ridge), and (5) on 6 ft. tied ridges at 3 ft. $\times$ 1½ ft. (two rows per ridge). The site of this experiment was of very patchy fertility on newly cleared land, and as a result the standard error was high. No benefits resulted from ridging in this season. The results are presented in Table 8.

TABLE 8.—MEAN YIELD OF SEED COTTON IN POUNDS PER ACRE

TREATMENTS					
1	2	3	4	5	S.E.
670	527	682	698	671	± 65.32

Groundnuts

Observation trials were planted at Shimba Hills to examine the possibility of groundnuts as a cash crop there, where they had not previously been tried. Two series of plots were laid out. In the first the local variety was compared with Natal Common, Barbeton, and Maito, both on the flat and on 3 ft. ridges, planted early and at the normal time, and with and without phosphate at 1½ cwt. of double superphosphates placed at planting time. In the second series of plots Uganda Bunch and Natal Common were cultivated on the flat, 3 ft., and 4½ ft. ridges, again with and without 1½ cwt. of double superphosphate, and at a spacing of 18 in. $\times$ 6 in. and 36 in. $\times$ 6 in.

The use of phosphate trebled the yield of groundnuts in both series. With regard to varieties poor yields were obtained from all in the absence of phosphate; in its presence Natal Common was the best yielder followed by Barberton and the local variety. Closer spacing gave better results than the wider. The effects of ridging and planting date were inconclusive. The main results of interest are presented in Table 9.

TABLE 9.—MEAN WEIGHT OF GROUNDNUTS (UNSHELLED) IN POUNDS PER ACRE (FIRST SERIES)

Varieties		Fertilizer	
Maito ..	1,178	No phosphate	607
Local ..	1,365	Phosphate ..	2,010
Barberton ..	1,277		
Natal Common	1,417		

(SECOND SERIES)

Spacing		Fertilizer	
18 in. x 6 in. ..	1,742	No phosphate	831
36 in. x 6 in. ..	1,485	Phosphate ..	2,503

The main disease of the crop was *Cercospora personata* to which the varieties showed very different degrees of resistance. It was serious on Barberton and Natal Common causing heavy premature defoliation. *Fusarium* wilt was not serious.

Short-term Resting Crops

The 4×2×2 factorial trial, in two replicates of a 2⁴ design, started in 1953 was concluded in 1956, test crops being grown in the Long and the Short Rains. The resting treatments during the experiment were as follows:—

A. Annual treatments: a₁, Long Rains sorghum—Short Rains beans—continuous cultivation; a₂, Long Rains sorghum—Short Rains teff grass dug in; a₃, Long Rains sorghum—Short Rains velvet beans dug in; a₄, Long Rains sorghum—Short Rains velvet beans cut and used as a mulch.

B. Farmyard manure at 3½ tons per acre (M) vs. Nil applied at the beginning of the experiment 1953.

C. 1 cwt. double superphosphate (P) vs. Nil also applied in 1953.

These A treatments were applied annually until and including 1955. The cultivations were on 3 ft. ridges and in treatments a₁, a₂ and a₃ the organic matter was incorporated by splitting the ridges. The results from the Long Rains crop of sorghum in 1956 showed treatments a₁, a₂ and a₃ to be much superior to treatment a₄ where the ridges were not split but moulded up annually and the velvet beans left on the surface as a mulch. This is interesting since it shows that soil fertility can be maintained with remarkable success with continuous cultivation if all weeds and crop residues are incorporated effectively. The Long Rains crop also showed good residual effects from the phosphate, and the phosphate combined with manure treatments, both applied in 1953. The results are presented in Table 10. The yields from this sorghum crop were easily the best of any produced during the course of the experiment.

TABLE 10.—MEAN YIELD OF TREATMENTS IN CWT. OF SORGHUM GRAIN PER ACRE

	(1)	P	M	PM	Means
a ₁	13.50	16.87	16.62	20.93	16.98
a ₂	14.02	16.09	14.98	20.79	16.47
a ₃	15.20	23.39	14.80	18.16	17.89
a ₄	8.71	11.43	9.12	12.25	10.38
Means ..	12.86	16.95	13.88	18.03	15.43

S.E. of a marginal mean = ±0.662

L.S.D. between marginal means	5%	1%	0.1%
	2.01	2.79	3.88

Ridging

A 7×7 Latin square trial to compare various ridging techniques and flat cultivation was started in 1955, and was continued in 1956. In 1956 a basic dressing of phosphate was applied at the rate of 1 cwt. of double superphosphate per acre. The full treatments in 1956 were as follows:—

- A. 3 ft tied ridges—moulded annually—normal placement of phosphate.
- B. 3 ft. tied ridges—split annually—normal placement of phosphate.
- C. 6 ft. tied ridges—split annually—normal placement of phosphate.
- D. 6 ft. tied ridges—moulded annually—normal placement of phosphate.
- E. 3 ft. tied ridges—split annually—deep placement of phosphate.
- F. 6 ft. tied ridges—split annually—deep placement of phosphate.
- G. Flat cultivation and normal placement of phosphate.

A crop of sorghum was grown in the Long Rains on a rainfall of 13.38 in. The distribution of the rain was good and so was the resulting crop. No significant differences showed in the results except that the yield where the phosphate was placed deep in the 6 ft. ridges was lower than on other treatments. This was due to the fact that this deep placed phosphate was too far from the sorghum planted in two rows 3 ft. apart on either side of the ridge.

In the Short Rains a crop of cow peas was grown without further cultivation or additional fertilizer, but due to the poor rains the crop was very light. The crop on the 6 ft. ridges with deep placed phosphate this time was comparatively good probably due to the dispersion of the fertilizer since the original application. The main results are presented in Table 11.

TABLE 11.—MEAN YIELDS OF (a) SORGHUM GRAIN IN CWT. PER ACRE AND
(b) COW PEA SEED IN POUNDS PER ACRE

		A.	B.	C.	D.	E.	F.	G.	S.E.	L.S.D. 5%
Sorghum	..	21.60	22.67	23.71	22.35	21.78	16.96	20.90	1.30	3.79
Cow peas	..	111	78	123	111	104	138	98	18.8	54.4

Fertilizers

N.P.K. TRIAL

The single replicate of a 3³ factorial trial put down at Shimba Hills on a new site in 1955 continued in 1956. The treatments were:—

N at three levels 2 = 2 cwt. sulphate of ammonia per acre.
1 = 1 cwt. sulphate of ammonia per acre.
0

P at three levels 2 = 2 cwt. of double superphosphate per acre.
1 = 1 cwt. of double superphosphate per acre.
0

K at three levels 2 = 1 cwt. of muriate of potash per acre.
1 = $\frac{1}{2}$ cwt. of muriate of potash per acre.
0

The N and K treatments were reapplied for the 1956 Long Rains crop of maize, but no more superphosphate was put on. The 3 ft. ridges, in which the experiment was cultivated, were split for the maize crop. There were 23 in. of fairly well distributed rain during growth. Nitrogen shortages showed up in the poor colour of the crop especially where superphosphate at the higher rate had been applied without nitrogen or at the lower level of this element. This was also reflected in the yields. The residual effect of 1 cwt. of double superphosphate increased the yield of the maize by 6.92 cwt. per acre, whilst the residual effect of the 2 cwt. dressing was to increase the yield by 4.86 cwt. per acre only. A depressing effect, reaching significance, from the lower level of potash application appears to be anomalous. The main results are presented in Table 12.

TABLE 12.—MEAN YIELDS OF MAIZE IN CWT. OF GRAIN PER ACRE

N ₀ ..	..	14.44	P ₀ ..	..	10.87	K ₀	..	15.53
N ₁ ..	..	14.20	P ₁ ..	..	17.79	K ₁	..	13.69
N ₂ ..	..	15.75	P ₂ ..	..	15.73	K ₂	..	15.17

S.E. = ± 0.50

L.S.D. between means 5% 1%
 1.50 2.07

The Short Rains crop of green gram was light due to poorish rains. The results presented in Table 13 generally confirm those from the Long Rains but the effect of deficient nitrogen is absent. No further reapplication of fertilizer had been made for this crop.

TABLE 13.—MEAN YIELDS OF GREEN GRAM IN POUNDS PER ACRE

N ₀ ..	..	181	P ₀ ..	..	74	K ₀	..	139
N ₁ ..	..	143	P ₁ ..	..	180	K ₁	..	133
N ₂ ..	..	130	P ₂ ..	..	200	K ₂	..	182

S.E. = ± 25.8

L.S.D. between means 5% 1%
 78 112

TYPES OF PHOSPHATE

The 3³ factorial trial, in a single replicate, started in 1955 at Shimba Hills to compare Seychelles Guano and Uganda Rock phosphate with superphosphate continued in 1956. The treatments were as follows:—

Types of phosphate applied in 1955—

T₂=816 lb. Uganda Rock phosphate per acre.

T₁=600 lb. Guano per acre.

T₀

Double superphosphate applied in 1955—

P₂=2 cwt. of superphosphate per acre.

P₁=1 cwt. of superphosphate per acre.

P₀

Repetitive treatments applied in 1956—

R₂=816 lb. Uganda Rock phosphate per acre.

R₁=600 lb. Guano per acre.

R₀

As previously reported superphosphate gave highly significant responses in 1955, with much smaller but still significant responses from the Guano and Uganda Rock phosphate applied in that year. In 1956 no fully significant responses were obtained except for the residual effect of the 1955 applied Guano. The repetitive treatments with Guano and Uganda Rock phosphate gave no indication of any response.

Rainfall, at a total during growth of 23 in., allowed a fairly good crop of maize to be obtained. The main results are given in Table 14. The depressing tendency of the higher rate of superphosphate is again evident.

TABLE 14.—MEAN YIELDS IN CWT. OF MAIZE GRAIN PER ACRE

T ₀ ..	..	17.22	P ₀ ..	..	19.01	R ₀	..	20.56
T ₁ ..	..	23.49	P ₁ ..	..	23.57	R ₁	..	19.96
T ₂ ..	..	20.44	P ₂ ..	..	18.57	R ₂	..	20.63
S.E. = ± 2.05								
L.S.D. between means								
				5%				
				6.16				

Due to poor rains, the Short Rains crop of green gram was a partial failure.

RIDGING, MULCHING AND FERTILIZING TRIAL

A 3³ factorial trial, in two replicates, was started at Shimba Hills in 1956 to compare the following treatments:—

Ridging	R ₂	4½ ft. ridges.
	R ₁	3 ft. ridges.
	R ₀	Flat cultivation.
Mulching	M ₂	Heavy imported mulch of dried grass.
	M ₁	Light mulch of crop residues.
	M ₀	No mulch.
Fertilizer	P ₂	1 cwt. of double superphosphate deep placed.
	P ₁	1 cwt. of double superphosphate normally placed near the seed.
	P ₀	No phosphate.

The site of the trial was on newly ploughed land. A basic dressing of five tons of manure was applied and was dug in on the flat or incorporated in the centre of the ridges together with the grass. The deeply placed phosphate was put in at plough sole depth on the flat and on the incorporated organic matter in the ridges. The Long Rains crop of maize was poor and obviously suffered from nitrogen shortage. No significant responses showed up in this crop. The Short Rains green gram crop, where no nitrogen shortage existed, showed markedly significant responses to mulching and phosphate. There was a steady increase in yield for first the lighter, and then the heavier mulch, and the lower and the heavier dressings of phosphate. In this first season ridging has given no improvement. The results for the Long and Short Rains crops are presented in Table 15.

TABLE 15.—MEAN YIELDS OF MAIZE GRAIN IN CWT. PER ACRE

R ₀ ..	..	8.72	M ₀ ..	..	7.98	P ₀	..	8.78
R ₁ ..	..	8.83	M ₁ ..	..	8.96	P ₁	..	7.98
R ₂ ..	..	7.93	M ₂ ..	..	8.54	P ₂	..	8.72
S.E. = ± 0.545								
L.S.D. between means								
				5%	1%			
				1.60	2.18			

MEAN YIELDS OF GREEN GRAM SEED IN POUNDS PER ACRE

R ₀ ..	..	305	M ₀ ..	..	236	P ₀ ..	..	215
R ₁ ..	..	308	M ₁ ..	..	305	P ₁ ..	..	326
R ₂ ..	..	312	M ₂ ..	..	384	P ₂ ..	..	384
S.E. = ± 13.8								
L.S.D. between means								
				5%	1%			
				40.5	55.0			

METHODS OF APPLICATION OF FARMYARD MANURE AND RESIDUAL EFFECTS

This trial started in 1953, continued in 1956. Details of treatments and design have been given in a previous report. Results continued to show responses to manure, and also that an annual three-ton dressing of manure seems to be preferable to the nine-ton dressing applied once every three years. Consistent results are obtained from the light annual dressing whereas there is generally a rapid falling off residual effects from the heavier dressing applied once every three years. Results also showed that yields could be well maintained on these sandy coastal soils for at least four years by the annual application of fertilizers equivalent in nitrogen, phosphate, and potash to the three-ton dressing of manure. There was no marked run-down of fertility since the beginning of the experiment in 1953, even the control plots giving fair yields.

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